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Camp Dresser & McKee

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2010300074
S.E. ROCKFORD
SF/TECH
VOL. 1 OF 2

**Illinois Environmental Protection
Agency**

**Final Remedial Investigation Report for the
Southeast Rockford Source Control Operable Unit**

July 25, 2000

EPA Region 5 Records Ctr.



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*Report (Volume 1 of 2)
Appendices (Volume 2 of 2)*



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July 25, 2000

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Springfield, Illinois 62794-9276

Subject: Final RI Report for the Southeast Rockford SCOU
2010300074 Winnebago

Dear Jerry:

Camp Dresser & McKee Inc. (CDM) is pleased to submit six copies of the final remedial investigation report for the Southeast Rockford Source Control Operable Unit (SCOU) in Rockford, Illinois. The final report consists of text and appendices, bound separately as Volume 1 and Volume 2, respectively. This report incorporates Illinois EPA's comments on the draft report, which was submitted in May 1997.

Please contact Snehal Bhagat (312-251-8760) with questions or comments regarding this submittal. Thank you.

Sincerely,

Ronald D. French
CAMP DRESSER & McKEE INC.

Cc: Snehal Bhagat
File

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- F Raw Surveying Data
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LIST OF ABBREVIATIONS

1,1-DCE	1,1-Dichloroethene
1,2-DCE	1,2-Dichloroethene
BETX	Benzene, ethylbenzene, toluene, xylene
bgs	Below ground surface
CAS	Chemical Abstracts Service
CLP	Contract Laboratory Program
CDM	Camp Dresser & McKee Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRQL	Contract Required Quantitation Limit
DCA	1,1-Dichloroethane
DNAPL	Dense non aqueous phase liquid
DO	Dissolved oxygen
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
FS	Feasibility Study
GC/MS	Gas chromatography/mass spectroscopy
Hnu	Hnu Photoionization Detector
IEPA	Illinois Environmental Protection Agency
LNAPL	Light non aqueous phase liquid
mg/kg	Milligrams per kilogram
MS	Matrix spike
MSD	Matrix spike duplicate
msl	Mean sea level
MW	Monitoring well
NAPL	Non aqueous phase liquid
OVA	Organic Vapor Analyzer
OVM	Organic Vapor Monitor
PCB	Polychlorinated biphenyls
PCE	Tetrachloroethene or Perchloroethene
pH	Hydrogen ion concentration
PID	Photo Ionization Detector
ppb	Parts per billion
ppm	Parts per million
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SB	Soil boring
SG	Soil gas

SCOU	Source Control Operable Unit
SVOC	Semi-volatile organic compound
TAL	Target Analyte List
TCA	1,1,1-trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TIC	Tentatively identified compound
ug/kg	Microgram per kilogram
ug/L	Microgram per liter
U. S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile organic compound

Section One

Section 1

Introduction

1.1 Background

1.1.1 Study Area Description

The Southeast Rockford Source Control Operable Unit (SCOU) study area is located in Rockford, Illinois in Winnebago County, covering an area of approximately 10 square miles. The study area is bounded by Broadway to the north, Sandy Hollow Road to the south, Mulford Road to the east, and the Rock River to the west (Figure 1-1). The SCOU study area is predominantly suburban residential with scattered agricultural, industrial, retail and commercial operations. Specifically, Area 4 contains a trailer park and one industry that is no longer in operation. Area 7 consists of agricultural land as well as a city park and playground. Areas 9/10 and 11 are mostly industrial with some scattered retail and commercial operations.

The Winnebago county lies within the Rock River Hill Country physiographic province. The topography and physiography of the county is generally controlled by the subsurface topography of the bedrock. The area surrounding the SCOU study area is flat-lying and slopes gently westward toward the Rock River. Locally the study area contains low-relief hilly areas. The maximum topographic relief across the study area is 160 feet.

The stratigraphy of the study area consists of bedrock overlain with glacial deposits (Figure 1-2). The glacial deposits are unconsolidated with variable thickness across the site. The uppermost bedrock units are dolomite and sandstone, which form a subsurface valley over 200 feet deep in the western part of the study area (Figure 1-3). The bedrock surface is narrow and forms an east-west valley that deepens toward the west. The bedrock units have uniform lithology but contain higher permeable zones which may be related to vugs, fractures, and solution zones present at or near the surface of the bedrock unit. Glacial deposits fill the bedrock valleys. The unconsolidated units change laterally parallel to the axis of the bedrock valley. Unconsolidated units consist of silt and clay units and sand and gravel units.

The glacial deposits and the bedrock constitute two hydraulically connected aquifers; no really extensive confining layers have been identified between the unconsolidated deposits and the dolomite bedrock. Groundwater flow is generally westward at the across the source study areas. The mean hydraulic conductivity of the unconsolidated aquifer is 8.3×10^{-4} cm/s (CDM 1995). The mean hydraulic conductivity of the bedrock aquifer is 9.1×10^{-4} cm/s.

ERA	SYSTEM	SERIES	MEGA-GROUP	GROUP	FORMATION	
CENOZOIC	QUATER-NARY	PLEISTO-CENE				
PALEOZOIC	ORDOVICIAN	CHAMPLAINIAN	OTTAWA	GALENA	DUBUQUE	
					WISE LAKE	
					DUNLEITH	
					GUTTENBERG	
				PLATTEVILLE	QUIMBYS MILL	
					NACHUSA	
					GRAND DETOUR	
					MIFFLIN	
					PECATONICA	
					GLENWOOD	
		CANADIAN		ANCELL	ST. PETER	
					KRESS MBR.	
	CAMBRIAN	CROIXAN	KNOX	PRAIRIE DU CHIEN	SHAKOPEE	
					NEW RICHMOND	
					ONEOTA	
					GUNTER	
			POTSDAM			EMINENCE
						POTOSI
						FRANCONIA
						IRONTON-GALESVILLE
						EAU CLAIRE
						MT. SIMON
PRECAMBRIAN						




SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
GENERALIZED STRATIGRAPHIC COLUMN
OF WINNEBAGO COUNTY

CDM

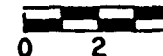
environmental engineers, scientists,
planners, & management consultants



LEGEND:

-  GALENA GROUP
-  PLATTEVILLE GROUP
-  ANCELL GROUP

SCALE IN MILES



SOURCE: GEOLOGY FOR PLANNING IN BOONE AND WINNEBAGO COUNTIES.
BERG, KEMPTON, STECYK (1984).

SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT

BEDROCK SURFACE MAP OF WINNEBAGO COUNTY

1.1.2 Study Area History

Area 4

Source Area 4 is located east of Marshall Street and south of Harrison Avenue. Barrett's Trailer Park, a residential area, is located around Area 4. Swebco Manufacturing, Inc. was located in Area 4 at 2630 Marshall Street. The facility was formerly a precision machining shop producing metal parts. According to available records, the facility used a solvent, although the contents were not specified. Information indicates that naphthenic distillate petroleum, hydrocarbons, and mineral spirits were all components of compounds used at the facility. There are three underground storage tanks present in unknown condition and available information indicates they are likely empty. The past contents are reported to have been fuel oil and waste oil. Benzene, toluene, ethylbenzene and xylene (BTEX) contamination was detected around the area of the tanks during a previous investigation. Past known spills in the area consisted of two spills of water-soluble coolant.

Area 7

Source Area 7 is primarily an open area located at the east terminus of Balsam Lane that encompasses a city park (Ekberg Park) and open fields containing wooded areas. Ekberg Park consists of paved basketball and tennis courts, a children's playground and park, and lawn areas. Open field and wooded areas exist south of the park on a hillside which slopes to the north. Two small valleys, which merge at the base of the hill, drain surface runoff northward and through the park with discharge to an unnamed creek bordering the north side of Area 7. Open farm field separates the north side of Ekberg Park and the creek. Private residences are located along the west (Balsam Lane) and southeast (O'Connell and New England Drives) margins of Area 7.

Part of Area 7 was once a gravel pit as shown on the Rockford South Quadrangle map (USGS 1976) and examination of aerial photographs since the 1950s indicates that various disposal activities occurred at this location. In particular, the 1970 photo shows areas of excavation and disturbed ground in two large areas centered at about 600 and 1,300 feet east of the east end of Balsam Lane. A third suspect area is located along the small tributary valleys passing from southeast to northeast of Balsam Lane. In these valleys, debris and unvegetated spots are visible on the 1958, 1964, and 1970 photos. In addition, USEPA received a report of illegal dumping in the past in Area 7.

Area 11

Area 11 is located north of Harrison Avenue and east of 11th street. Historically, manufacturing in Area 11 has included the production of paint and various varnish products for the furniture industry (formerly Rockford Varnish and Rockford Coatings facilities) and gears and rollers for newspaper presses (formerly Rockwell Graphics Systems). Presently, a restaurant (Villa di Roma), machinery painting

facility (Rohr Manufacturing), and wood products supplier (H & H Wood Products and Pallets, 1702 Harrison Avenue) are active businesses in Area 11. The following discussion details the activities and operational histories of each Area 11 facility.

Rockford Coatings Corporation, formerly located at 1620 Harrison Avenue, manufactured several paint products including air-dry and baking enamels, lacquers and water-based paints. Manufacturing derived waste was handled by ACME Solvents from the 1950s to early 1980s. However, the use of chlorinated solvents at the facility is unknown. The Rockford Coatings Corporation discontinued operations in 1983 and Mackey Properties presently owns the building.

Rockford Varnish Company, formerly at 11th Street and Harrison Avenue, manufactured varnish and related products for the furniture industry. The facility operated from 1906 to 1983. Rockford Varnish used volatile organic compounds (VOCs) including chlorinated solvents in its operations. Groundwater sampling results from wells nearby former Rockford Varnish indicate chlorinated solvent VOC contamination. Presently, the Villa di Roma Restaurant and parking lot occupies a section of the former Rockford Varnish facility. Also, a wood products firm (H & H Wood Products and Pallets) currently operates at the former facility location.

Rockwell International Graphics, formerly located at 2524 11th Street, manufactured gears and rollers for newspaper presses until approximately 1991. The facility used 1,1,1-trichloroethane (TCA) for cleaning rollers until 1983. The property is now owned by P.H. Partners Co., who lease it to Rohr Manufacturing. Present operations include painting industrial equipment. A railroad right-of-way, located south of and adjacent to the property, is owned by Aetna Plywood.

Dames and Moore (1990) performed an environmental assessment of the property titled, "Environmental Assessment, Former Railroad Right-of-Way," (Dames & Moore, 1990), which revealed several areas of environmental concern, as briefly outlined below. One area of concern included a section of stained soil adjacent to a concrete slab on the P.H. Partners property. It appeared that a Rockwell Graphics dumpster had leaked cutting oils onto the ground surface. A soil sample from beneath the dumpster contained 15,900 mg/kg total petroleum hydrocarbons (TPH) and 21.3 µg/kg of trichloroethene (TCE). Groundwater analytical results from monitoring well MW-3, located nearby, yielded 2.5 µg/L of tetrachloroethene (PCE), 36.6 µg/L of TCA and 7.4 µg/L of TCE. Also, a pit to the north of the former Rockwell Graphics property contained standing water with an oily sheen and a soil sample adjacent to this pit contained 460 mg/kg of TPH.

Two areas of potential concern exist in the right-of-way south of the former Rockwell Graphics property. First, a bunker, reportedly used by Rockford Varnish Company had previously seeped a tar-like substance. Groundwater VOC results from a nearby monitoring well (MW-2) indicated 1,150 µg/L of TCA and 302 µg/L of TCE. The second area of concern was near the above-ground storage tanks located partly within and to the south of the right-of-way. A monitoring well (MW-1) in the right-of-way

and near these tanks did not indicate contamination from chlorinated solvents, but did show a concentration of toluene at 604 mg/L.

The Area 11 groundwater contaminant plume consists primarily of aromatics (xylene, toluene and ethylbenzene), though elevated concentrations (up to 2,900 µg/L) of several chlorinated VOCs are also present in the vicinity. Results from the Phase II investigation (CDM 1995) indicate two separate non-aqueous phase liquids (NAPLs) in Area 11, the larger NAPL has a thickness of generally 5 to 10 feet and locally as great as 25 feet. This NAPL is a light NAPL due to its presence at or near the top of the water table.

Area 9/10

Area 9/10 is an industrial area that is bounded by 11th Street on the east, 23rd Avenue on the north, Harrison Avenue on the south, and 6th Street on the west. This part of the study area has a long history of industrial activity that extends as far back as 1926 when the Rockford Milling Machine and Rockford Tool companies merged to become the Sundstrand Machine Tool Company, located at the northwest corner of 11th Street and Harrison Avenue (Lundin 1989). Current industries in the area include Sundstrand Corporation's Plant #1 (2421 11th Street), which extends from 11th Street westward to 9th Street, and the former Mid-States Industrial, Nylint Corporation, Paoli Manufacturing, Rockford Products Corporation, the former Rohrbacher Manufacturing, and J. L. Clark.

During the Phase I (CDM 1992) and Phase II (CDM 1995) investigations, a limited soil gas survey and subsurface drilling were conducted in the former Area 9 (west of 9th Street) and former Area 10 (east of 9th Street). "Area 9/10" has been retained for the SCOU because both the west (Area 9) and east (Area 10) sides of 9th Street were investigated.

1.1.3 Summary of Previous Investigations

Area 4

Source Area 4 was designated as a potential source area before the Phase I investigation due to elevated levels of TCA (991 µg/L) in a downgradient private well. During the Phase I of the Remedial Investigation/Feasibility Study (RI/FS), 10 soil gas samples were taken in Area 4 to determine the origin of contamination. The highest concentrations of TCA and TCE during the Phase I investigation were detected in this area. The second highest concentration of PCE was also detected at the same sampling point (SG4-10) as the TCA and TCE concentrations. Groundwater monitoring wells are not located within Area 4, but there are wells downgradient of the area. The sample analysis of these wells indicated that chlorinated VOCs are present in the groundwater. The soil gas data from Area 4 coincides with the groundwater data.

The Phase II field investigation was targeted at finding the source area. Additional soil gas points and soil borings (six) were taken during the Phase II investigation. Concentrations up to 360 mg/kg of TCA were discovered at the top of the saturated zone in the soil borings. Based on the findings of the previous investigations, the estimated area of contamination in Area 4 is a 50 feet by 75 feet area at a depth of 8 feet. Three of the soil borings taken at the northern end of the parking lot of Swebco Manufacturing, Inc. showed the presence of a dark oily substance at the saturated zone. Two surface soil samples were collected in Area 4 to determine the amount of surface contamination. VOCs, semivolatiles (mostly PAHs), and metals were detected in the surface soil samples. The Phase II groundwater investigation also linked this area with groundwater contamination. TCA and TCE were detected downgradient of the source area at concentrations of 1,000 µg/L and 28 µg/L, respectively.

Area 7

The investigation of a possible contaminant source in Area 7 was sparked by the elevated contaminant concentrations in one monitoring well set in the unconsolidated sediments (MW106A). As noted in the Phase I Technical Memorandum (CDM, 1992), a contaminant source was suspected nearby, based on the fact that elevated contaminant concentrations were found only in the shallow well at MW106, while medium and deep wells (MW106B and C) had very low contaminant concentrations. In addition, contaminants were not found in well nests MW108 and 109, located roughly upgradient from MW106. Examination of aerial photographs after the Phase I investigation revealed that the area upgradient (east) of MW106 had been the site of various activities since the 1950s. This portion of Area 7 is now part of Ekberg Park, which is owned by the Rockford Park District. In particular, the 1970 photo shows areas of excavation and disturbed ground in two large areas (Areas 7a and 7b) centered at about 600 and 1,300 feet east of MW106 (Figure 1-4). A third suspect area (Area 7c) consists of several small tributary valleys passing from southeast to northeast of MW106 and as close as 200 feet east of the well nest. In these valleys, debris and unvegetated spots are visible on the 1958, 1964, and 1970 photos. In addition, USEPA received a report of illegal dumping in the past in Area 7.

Based on these lines of evidence suggesting possible contaminant sources in Area 7, a site visit was made by IEPA and USEPA personnel in March 1992. During this visit, surficial evidence of waste disposal (municipal waste such as household appliances and glass, medical waste such as syringes, and assorted rusted drums and paint cans) was discovered and a preliminary terrain conductivity survey was performed. The conductivity survey indicated that buried metal was present at the site. As a result, a more detailed investigation of Area 7 was performed in May 1992. This investigation consisted of a ground-penetrating radar survey conducted by USEPA's Technical Support Section, Office of Superfund, Region 5, a terrain conductivity survey conducted by CDM, and a soil gas survey conducted by Tracer Research Inc. and CDM. A 50-foot grid was laid out to cover most of Ekberg Park and the open field south of it (Areas 7a, 7b, and 7c), and the investigation performed in May 1992 followed this grid. The ground-penetrating radar and terrain conductivity surveys

DISTURBED AREAS 1958-1964

AREA 7c

PLAYGROUND 1991

FORMER
SMALL VALLEY
(BEFORE 1988)

BALSAM LANE

DISTURBED AREA
1970

MW 106

DISTURBED AREA 1970
BASKETBALL
COURTS 1991

DISPOSAL AREAS
1958-1970

SMALL VALLEY

DISPOSAL AREA
1951-1964

TREES

DISTURBED AREA
1970-1978

AREA 7b

AREA OF
EXCAVATION AND
DISTURBANCE
1970

AREA OF
EXCAVATION
1958-1964

POND 1991

DISTURBED AREA
1988-1991

DISPOSAL AREA
1958-1970

SMALL VALLEY

DISTURBED AREAS
1970-1988

AREA 7a

AREA OF EXCAVATION
AND DISTURBANCE
1970-1988

HOUSES

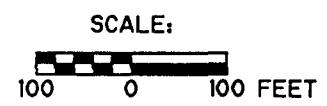
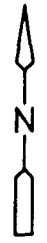
O'CONNELL ST.

HOUSES

HOUSES

NEW ENGLAND DR.

HOUSES



LEGEND:

—+—+—+— SURVEY GRID

CURRENT FEATURES

PAST FEATURES (DATES INDICATE MINIMUM PERIODS OF DISTURBANCE OR LAND USE BASED ON AERIAL PHOTOGRAPHY)

SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
**AREA 7 CURRENT AND
PAST FEATURES**

Figure No. 1-4

CDM

environmental engineers, scientists,
planners, & management consultants

Sellgarb

0.06:10

07/19/00 11:36:56

Fig1-4

RFINAL\Other\

S:\168

showed similar results, with anomalies present in the Y-shaped set of small valleys of Area 7c. The anomalies range from 25 to 75 feet wide and extend from the south side of the tennis courts, south and southeast toward the southwestern and southeastern corners of the surveyed area (at the 0 north line in Figure 1-4); the full extent of the anomalous area was not defined by the geophysical surveys.

Soil gas sampling in Area 7 was conducted in two episodes: in May 1992, and in February 1993. The major portion of the work was conducted in May 1992; at this time, 78 soil gas samples were collected across the 50-foot grid across the three suspect areas east of MW106. An extensive area of elevated concentrations of the target compounds was found in soil gas samples collected from Area 7c. As a result, an additional 15 samples were collected in February 1993, to better define the western, northwestern, and southwestern extent of contaminants in soil gas in Area 7c. The north end of Area 7 was not fully characterized by the soil gas effort in Phase II.

The soil gas sampling in Area 7 showed the largest area of soil gas contamination delineated in the Phase II RI, as well as some of the highest contaminants detected. In general, the area of soil gas contamination followed the geophysical anomalies defined by the terrain conductivity and ground-penetrating radar surveys: no significant soil gas or geophysical anomalies were detected in the two larger suspect areas east of MW106 (Areas 7a and 7b), but extensive anomalies were detected in each survey in the small valleys closer to MW106 (Area 7c). However, soil gas results differed from the geophysical surveys in two respects: 1) only small soil gas anomalies were detected in the eastern valley of Area 7c located near grid point 200 N, 350 E, while geophysical anomalies were large in this area; and 2) the soil gas anomalies are generally approximately 200 feet wide, considerably wider than the geophysical anomalies, which are generally only about 50 feet wide.

Of the three target compounds (TCA, TCE, and PCE), TCA was generally the most abundant compound detected in Area 7c soil gas samples; this pattern was repeated in the subsurface soil sampling results (see subsection 4.5 of the Phase II RI Report, CDM, 1995). As discussed in the Phase II report, TCA in soil gas was detected at elevated concentrations from numerous locations in Area 7c, ranging up to 3,800 $\mu\text{g}/\text{L}$. The highest concentrations were found in a roughly north-south band along the western and northern small valleys. A continuous band of TCA soil gas concentrations greater than 100 $\mu\text{g}/\text{L}$ is approximately 200 feet wide and extends about 800 feet from north to south; the total extent of the area with anomalous (greater than 1 $\mu\text{g}/\text{L}$) TCA soil gas concentrations is on the order of 300 by 1,100 feet, though the northern and northwestern perimeter were not completely defined. The Area 7c TCA results clearly indicate that, of the potential source areas surveyed for soil gas contaminants in the RI, Area 7c has the most extensive area with elevated concentrations of the target compounds. Based on these results, Area 7c was selected for further investigation during Phase II as a potential source; the additional work consisted of test-pit excavation, surface and subsurface soil sampling, and monitoring well installation.

Investigations through the Phase II RI indicate that Area 7 has a significant impact on groundwater contamination.

Area 11

Previous investigative activities in Area 11 included soil gas, subsurface soil, and groundwater sampling to delineate petroleum-related and chlorinated VOC soil and groundwater contamination. Due to access limitations during Phase II of the RI, soil gas sampling was conducted only in the southwestern part of Area 11 in the parking lot of the Villa di Roma Restaurant. Although no elevated concentration of the target compounds, TCE, PCE and TCA were detected, these samples were collected south of the area with the reported contaminant releases. Following access acquisition, subsurface borings were advanced in the former railroad right-of-way south of the current Rohr Manufacturing building and north and northeast of the Villa di Roma parking lot.

Previously, eleven subsurface borings were drilled and sampled in Area 11, including one in which well MW128 was installed. Analytical results and head-space screening for the subsurface soil samples indicated that there were two distinct areas of BETX contamination in Area 11. The first area includes the western margin of Area 11 north and south of Rohr Manufacturing. The second contaminated area includes the area surrounding the above-ground storage tanks. Subsurface soil VOC contamination in both areas was dominated by the aromatic compounds toluene, ethylbenzene and xylenes (ETX) at very high concentrations ranging up to 1,400 mg/kg, 590 mg/kg, and 2,200 mg/kg, respectively. Additionally, moderate concentrations of methylene chloride (410 to 2,200 µg/kg), benzene and TCE were reported from one soil sample each, and relatively low concentrations were reported for several other compounds including acetone, methylene chloride, TCA, and carbon disulfide.

The horizontal extent of contamination in the western area (Villa di Roma parking lot) was not determined to the north, west and south due to access and structural limitations of drilling. Similarly, the southern (area south of the aboveground storage tanks on former Rockford Varnish property) and northeastern (area north and east of Rohr Manufacturing) boundaries of the eastern contaminant zone were undefined. The vertical extent of contamination was estimated based on the correlation between field head-space measurements and soil analytical results (CDM 1995). The contaminated interval ranged from zero to 25 feet thick across Area 11 and was zero to 10 feet thick in 10 of the 11 soil borings. This high-concentration zone generally encompassed the interval from about 32.5 to 37.5 feet below ground surface but was also observed between 40 and 42 feet at SB11-128 and SB11-5 (Table 4-4; CDM 1995).

The composition and vertical pattern of the high contamination zone in Area 11 suggested the possibility of light non-aqueous phase liquid (LNAPL) residual with minor dense non-aqueous phase liquid (DNAPL) components. Although no specific testing was performed in Phase II (CDM 1995) to characterize or confirm the suspected NAPL near the water table (i.e. the monitoring wells were not screened at

the water table interface so the presence of NAPL could not be evaluated), the presence of NAPL was suspected for two reasons. First, the presence of residual NAPL was suspected based on the common presence of a gray-colored zone in the samples with high head-space results (CDM 1995). Second, the concentrations of toluene and xylene (up to 1,400 mg/kg and 2,200 mg/kg, respectively) were higher than the solubilities of these compounds in water (515 and about 220 mg/L, respectively). Based on the general lack of visible organic carbon in the sands of this area, sorption is not likely to account for the excess of toluene and xylene above their solubility limits. Rather, residual NAPL is the most likely explanation for the high contaminant concentrations. The high concentration of aromatic compounds in subsurface soils from Area 11 is consistent with the derivation of the contamination from varnish.

Historical Area 11 groundwater sampling results show the presence of VOCs, including chlorinated solvents, in the groundwater. Trichloroethene was detected in MW-2 (302 µg/L), IW-11 (170 µg/L) and MW129 (1 µg/L), respectively, and PCE was detected in MW129 at 1 µg/L. TCA was detected in MW-2 (302 µg/L) and MW129 (10 µg/L). Elevated levels of toluene have been detected in IW-10 (310,000 µg/L), IW-11 (140,000 µg/L), and MW128 (9,200 µg/L). Ethylbenzene (1,800 µg/L at IW-11 and 3,900 µg/L at MW128) and xylenes (8,000 µg/L at IW-11 and 16,000 µg/L at MW128) were also present at elevated levels. Acetone, 2-butanone, benzene, and several SVOCs were also detected at low levels in MW128. Generally, Area 11 groundwater and subsurface soil sample results from similar depths show that, in groundwater contaminant plume areas away from contaminant source areas, soil samples have contaminant concentrations of less than 100 µg/kg (CDM 1995).

Area 9/10

During previous studies, soil gas work in Area 9 centered on the area immediately north of the intersection of Harrison Avenue and 8th Street, adjacent to the former Libby Oil and Chemical and Brand Oil facilities. Two of the six Phase II soil gas samples (refer to Appendix G2 in CDM 1995 for sample locations) collected from Area 9 contained target compound concentrations greater than 1 µg/L. Samples SG9-4 and 9-5 contained elevated concentrations of the three target compounds in roughly similar proportions: in SG9-4, TCA, PCE, and TCE were detected at 120, 120, and 91 µg/L, respectively, while SG9-5 contained 18, 24, and 7 µg/L, respectively, of the same compounds. These results are also concordant with Phase I soil gas sample SG3-1 (CDM 1992). Owing to difficulty of access and lack of access to properties located east of location SG9-4, soil gas concentrations were not closed off to the east; it is possible that soil gas contaminant concentrations are higher to the east, and that a potential source area may lie to the east. Based on the elevated contaminant concentrations in Phase II soil gas samples, Area 9 was retained for further source screening in Phase II. The additional work consisted of subsurface soil sampling near location SG9-4 and downgradient monitoring well installation (MW125 and MW126 nest).

One subsurface boring was drilled and sampled in Area 9 (see Figure 4-23 in CDM 1995) to investigate the existence of VOC contamination at a location with moderately elevated detections of target compounds in soil gas (TCA, PCE, and TCE at 91 to 120 $\mu\text{g/L}$). Additional borings were not possible due to the presence of utilities. In this boring (SB9-1, located at the northwest corner of the former Libby Oil and Chemical), none of the subsurface soil samples displayed detectable VOCs in field head-space screening, and there was no visual evidence of contamination in any sample. Based on the lack of response in head-space screening, one sample was selected for laboratory analysis (the sample nearest to and above the water table); a duplicate was also collected. For volatiles and semivolatiles (which include extractables, pesticides, and PCBs), PCE was the only compound detected, at a concentration of 5 $\mu\text{g/kg}$ in both sample and duplicate. The detection of PCE in subsurface soil was consistent with its detection in the soil gas sample.

The soil gas samples and the one soil boring in Area 9 were located in the western portion; access problems precluded investigation of the eastern part of Area 9. As the elevated soil gas concentrations were not closed off to the east, the eastern part of Area 9 remained suspect. There was insufficient data from the western portion of Area 9 to fully evaluate any contaminant source of VOCs to groundwater. Area 9 was retained for further investigation as a potential contaminant source. Further work included installation of monitoring wells at four locations (MW123, MW124, MW125 and the MW126 nest). MW123 and MW124 are downgradient from the western portion of Area 9 and MW125 and the MW126 nest are located roughly downgradient (southwest) of the eastern part of Area 9.

Soil gas work in Area 10 centered on two areas roughly upgradient of ISWS well MW20. Though located in the main portion of the contaminant plume, in the past MW20 has shown higher contaminant concentrations (426 $\mu\text{g/L}$ of 1,1-DCA in March 1992) and different contaminant ratios than observed in wells upgradient. Two soil gas samples (refer to Appendix G2 in CDM 1995 for sample locations) in Area 10 had contaminant concentrations above 1 $\mu\text{g/L}$: SG10-11 had 3 $\mu\text{g/L}$ of TCA, and SG10-14 had 2 $\mu\text{g/L}$ of TCA. TCE and PCE were not detected at concentrations above 1 $\mu\text{g/L}$ in any samples from Area 10. The elevated contaminant concentrations in soil gas samples from the portion of Area 10 that was investigated are either not high enough or are not clustered together in a way consistent with the idea of a nearby contaminant source. However based on available information, the existence of contaminant source(s) is still possible in other portions of Area 10, along Harrison Avenue on the block east of Ninth Street (a portion of Area 10 where access was not acquired). In addition, the existence of elevated TCA at location SG10-14 may suggest a contaminant source located west of Ninth Street (in Area 9, west of Area 10), a short distance north of Harrison Avenue. As noted in the above discussion on Area 9, this portion of Area 9 was another area not accessible for soil gas work.

1.2 Purpose

The purpose of this Remedial Investigation Report is to present and interpret the results from the Source Control Operable Unit (SCOU) field activities conducted for the Southeast Rockford Groundwater Contamination Site from May 1996 through July 1996. Additionally, this report will incorporate data collected during the Phase II field activities and presented in the Final Remedial Investigation Report (CDM 1995) as appropriate to supplement the SCOU data.

The objectives of the Source Control Operable Unit investigation are to:

- delineate the horizontal and vertical extent of contaminant sources, including any NAPLs encountered;
- provide sufficient data to support the risk assessment and develop soil cleanup objectives; and
- provide detailed information to support source area remediation.

In support of these objectives, this report describes the source area characteristics (either in text or by reference), the nature and extent of contamination, and contaminant fate and transport mechanisms.

1.3 Organization of the Report

This Remedial Investigation Report is organized into five sections. This section provides a brief introduction to the area that includes background information, the purpose of the report and report organization. Section 2 provides a description of the methods and procedures used to gather the SCOU data and the usability of the data is discussed. The individual source areas are characterized in Section 3. Section 4 presents information regarding the fate and transport of the contaminants for each source area, and Section 5 provides the summary and conclusions for each source area.

Section Two

Section 2

Field Investigation Methods and Procedures

2.1 Field Quality Control Procedures

Field Quality Control (QC) procedures were performed throughout the investigation to ensure a high data quality level. QC sample requirements, summarized in the text and Table 2-1 of the Final Southeast Rockford Groundwater Contaminant Source Control Operable Unit Sampling and Analysis Plan Addendum (SAP) (CDM 1996a), were followed except where noted. Section 2.10 and Appendix A, Data Usability Evaluation (of this report) provides a detailed outline of the QC employed throughout this investigation.

Geoprobe Soil Gas

Soil gas samples (including QC samples) were collected using a Geoprobe rig operated by CDM subcontractor, Terra-Trace Environmental Services (Terra-Trace). Soil gas samples were analyzed using a field gas chromatograph by Terra-Trace subcontractor, Landmark Technologies, Inc. (Landmark). Landmark used several quality assurance/quality control gas chromatograph calibration procedures that included carrier gas blank and nitrogen blank analyses and a 5-point calibration standard. These continuing calibration standards were used to determine if any contamination existed in the analytical equipment or supplies.

At the beginning of each day, Landmark injected a carrier gas blank into the gas chromatograph to detect if any contamination was present within the syringes used to inject the soil gas into the GC. Because nitrogen served as the carrier gas for all samples, a nitrogen blank was then injected to determine if any contamination existed in the nitrogen or injection port insert. Following these initial calibrations, five gas standards with different concentration levels were injected and analyzed independently.

According to the SOP for Soil Gas Sample Collection and Analysis in the February QAPP addendum (CDM 1996b), the continuing calibration verification standards were performed at the start of each project day, after every 10 field samples, and at the end of each project day. However, these procedures were modified in the field to expedite sample analysis. Because the five-point calibration took two-hours to perform and slowed field soil gas analysis, the procedure was performed only at the beginning and end of each field day without jeopardizing data integrity.

System blank and ambient air samples were collected during the soil gas survey to determine if contamination existed in the sampling equipment or supplies. System blanks were ambient air samples drawn through an aboveground sampling probe

and complete sampling apparatus. Ambient air samples were collected near the system blank probe at the same time the system blank was taken.

Initially, three ambient air samples and three system blanks were to be analyzed daily (CDM 1996b). Because the QA/QC analyses used valuable time that could have been allotted for soil gas analysis, the procedure was modified during the survey so that one system blank and one ambient air sample was collected at the beginning and end of each day.

Geoprobe Soil Borings

Subsurface soil samples (including QC samples) were also collected using a Geoprobe rig operated by CDM subcontractor, Terra-Trace. Soil samples were analyzed by the U.S. EPA CLP (Contract Laboratory Program) laboratory.

Duplicate subsurface soil samples were collected and matrix spike/matrix spike duplicate (MS/MSD) were designated by the sample coordinator during the subsurface soil sampling investigation. Four subsurface soil duplicate samples were collected for volatile organic compound (VOC), Base/Neutral/Acid (B/N/A) extractable, polychlorinated biphenyl (PCB) and pesticide analyses in Area 9/10. Because Geoprobe subsurface soil samples were only analyzed for VOCs in Areas 4, 7, and 11, the duplicate samples (two) were submitted for VOC analysis only. Only VOCs were analyzed because they were the primary analytes of concern.

The SAP (CDM 1996d) specified one duplicate sample was to be collected for every 20 (or portion thereof) regular investigative samples. Thus, eight duplicates were required for 150 proposed VOC samples and five duplicates were necessary for the 88 proposed B/N/A, PCB and pesticide samples. However, access difficulties inhibited the collection of 150 samples for VOCs (136 were collected) and 88 samples for B/N/As, PCBs and pesticides (54 were collected). CDM collected a total of six duplicates for VOC analysis and four duplicates for B/N/A, PCB and pesticide analysis. The 1:20 duplicate to investigative sample ratio was exceeded for B/N/As, PCBs and pesticides but one short (6 instead of 7) for VOCs.

As specified in the SAP (CDM 1996d) one MS/MSD sample was designated by the sample coordinator for analysis by the U.S. EPA CLP laboratory. Trip blanks were not sent with the shipments of soil VOC samples, as per Table 2-1 of the SAP (CDM 1996d), because of an inadvertent shortage of trip blank samples. Data integrity was not adversely impacted by this omission.

Deep Soil Borings

CDM and subcontractor Terracon Consultants, Inc. advanced 13 of the 13 proposed deep soil borings using hollow stem auger and mud-rotary drilling methods. Continuous split-spoon samples were collected from each borehole and one duplicate sample was collected and analyzed for VOCs according to the SAP (CDM 1996d). Although four samples were analyzed for total metals and cyanide in Area 9/10, no

duplicate was taken as proposed (CDM 1996d) because of poor sample recovery. Data integrity was not adversely impacted by this omission.

Creek Surface Water and Sediment Sampling

Creek surface water and sediment samples were collected to characterize the northern boundary of Area 7, and QC samples were collected to verify data quality. CDM collected one duplicate water sample and one field blank for VOC, B/N/A, and PCB/pesticide analysis. The CDM sample coordinator designated one creek surface water sample as an MS/MSD sample. However, the proposed trip blank was inadvertently not shipped with the surface water samples. The lack of a trip blank did not compromise the integrity of the data. One duplicate creek sediment sample was collected and analyzed for VOCs, B/N/As, and PCBs/pesticides as specified (CDM 1996d).

Surface Soil Sampling

Surface soil samples were collected in areas where soil gas results indicated elevated VOC concentrations. One duplicate surface soil sample was collected and analyzed for VOCs, B/N/As, PCBs, pesticides, total metals and cyanide as specified in the SAP (CDM 1996d). Also, one MS/MSD sample was designated as specified.

Geoprobe Groundwater Screening Sampling

Geoprobe groundwater screening samples were collected during the field investigation to determine water quality and to select the proper placement of well screens for the newly installed monitoring wells. One duplicate groundwater sample was collected and analyzed for VOCs as specified in the July QAPP addendum (CDM 1996c). A trip blank was also shipped with the groundwater samples according to specifications.

Groundwater Sampling

Groundwater samples were also collected for further contaminant delineation and/or verification of past results. One groundwater VOC duplicate sample and one trip blank were analyzed as part of the groundwater quality control procedures outlined in the July QAPP addendum (CDM 1996c).

Decontamination Procedures

Personal and equipment decontamination procedures were followed as outlined in the SAP (CDM 1996d) and Southeast Rockford Health and Safety Plan.

Decontamination of the large equipment (i.e. drill rig) was performed at the decontamination pad located in the drum storage area, located near the Rockford Airport. The drum storage was used during the Phase I and Phase II investigations. All equipment (drill rigs, augers, probe rods, split-spoon samplers, hand tools and other sampling equipment) was decontaminated prior to initiation of work at the site

and between sample locations according to the SAP (CDM 1996d). Similarly, personal decontamination closely followed SAP (CDM 1996d) procedure.

2.2 Soil Gas Survey

CDM conducted a volatile organic compound (VOC) soil gas survey from May 20 through June 21 during the 1996 southeast Rockford Source Control Operable Unit field investigation. CDM contracted Terra-Trace to advance up to 298 soil gas probes in four separate operable units, which included Areas 4, 7, 9/10, and 11. Soil gas samples were analyzed using a field gas chromatograph by Terra-Trace subcontractor, Landmark.

The soil gas survey's purpose was twofold. First, soil gas results were used to place Geoprobe soil boring/sampling locations. Second, soil gas samples were taken to delineate the extent of contamination in each area. Area 4 surveying defined the extent of contamination in the eastern, northeastern, and southern margins of the area. Area 7 soil gas surveying delineated the northern and southwestern contaminant boundaries. Soil gas sampling in Areas 9/10 and 11 helped augment and finalize existing data.

Soil gas sampling followed the procedures outlined in the SAP (1996d) and Work Plan (CDM 1996a) unless noted otherwise. Soil gas samples were collected with the Geoprobe soil gas sampling Post-Run Tubing System (PRT) (CDM 1996d) procedure and analyzed using a field gas chromatograph for the following VOCs: 1,1,1-trichloroethane, 1,1-dichloroethane, tetrachloroethene, trichloroethene, trans- and cis-1,2-dichloroethene, vinyl chloride, benzene, toluene, ethylbenzene, and total xylenes.

The following list summarizes the total number of soil gas samples collected and sample depth ranges from each operable unit:

- Area 4: 35 locations at 15 feet below ground surface (bgs); Area 7: 8 locations at depths ranging from 4 to 20 feet bgs;(need SG7-122 to 124 depths) Area 9/10: 119 locations at depths ranging from 15 to 27.5 feet bgs; and Area 11 - # locations at depths ranging from 15 to 23 feet bgs .

Field Equipment Used

Terra-Trace used the Geoprobe System, that was mounted in the bed of a 1-ton pickup truck, to advance the percussion driven probe rods and collect soil gas samples. Soil gas samples were collected using the Post Run Tubing (PRT) method which is described in the SAP (1996d). Following collection, samples were transported to Landmark's field gas chromatograph (GC) laboratory for analysis. A gas chromatograph was used to analyze the samples and provide real-time results.

Field Methods Used

The PRT system was used to collect soil gas samples from discrete depths within the soil vadose zone. The 1-inch outer diameter (O.D.) (0.5-inch inner diameter) probe rods affixed with an expendable drive point were driven to the desired depth using the Geoprobe. The rods were then retracted a few inches leaving the drive point below and exposing the open rods to the soil. A length of 1/4-inch O.D. polyethylene tubing connected to an aluminum barbed fitting that contained an o-ring was threaded into the expendable point holder. The tubing was rotated clockwise from above to thread the barbed fitting into the female threaded expendable point at the base of the probe rods. The polyethylene tubing was connected to a vacuum pump with silicon tubing at the surface that was used to purge three to five volumes of soil gas from the PRT system tubing.

Following the purge, a vacuum chamber box fitted with an empty 1 liter Tedlar bag was attached to the PRT system tubing. A vacuum pump attached to the vacuum chamber box was then activated, creating a negative pressure inside the box and Tedlar bag. The air inlet port, connected to the Tedlar bag, was opened allowing soil gas to be drawn into the bag. Soil gas samples were stored in coolers (on ice) until gas chromatographic analysis.

The GC analytical procedure during the initial stage of the soil gas survey did not provide separate quantification of vinyl chloride and trans-1,2-dichloroethene because of co-elution. The analytical procedure was subsequently modified to allow separate quantification of trans-1,2-dichloroethene and vinyl chloride. The co-elution issue only affected one sample in Area 4 that exhibited detectable levels of vinyl chloride and trans-1,2-dichloroethene.

Although the Work Plan (CDM 1996a) specified quantification of benzene, toluene, ethylbenzene, and xylenes (BTEX) in Areas 9/10 and 11 only, these compounds were quantified for all samples. Because BTEX calibration was performed daily as part of the standard operating procedure, these compounds were analyzed for each soil gas sample with minimal additional time expended and at no added cost.

During the soil gas survey, several changes were made in response to field conditions and to accelerate the survey. Because the ground was saturated with water over much of Area 7, soil gas samples could not be collected at all locations. A 2-foot minimum sample depth, used to avoid collection of ambient air, also inhibited soil gas collection in the unsaturated areas. Thus where soil gas samples were not collected, Geoprobe soil samples were collected, containerized, heated, and the soil gas headspace was analyzed using an organic vapor analyzer. Soil samples were placed in a jar and heated in a 65 degree Celsius water bath for approximately 50 minutes. Each sample jar was then removed from the bath and the lid opened only enough to insert the organic vapor analyzer probe. Eight soil gas samples and 16 headspace samples were collected and analyzed from Area 7.

2.3 Geoprobe Soil Borings

CDM collected Geoprobe soil samples from June 12 through July 10 during the 1996 southeast Rockford Source Control Operable Unit field investigation. CDM contracted Terra-Trace to collect soil samples from 25 percent of the soil gas sampling locations to confirm the soil gas results and help delineate the extent of soil contamination. Soil borings were advanced at Source Areas 4, 7, 9/10 and 11. Soil samples, collected from two different depths at each location, were taken to confirm organic contaminant "hot spots" and locations with low or no detection, and to delineate the extent of soil contamination. Samples were analyzed by the U.S. EPA Contract Laboratory Program (CLP) for volatile organic compounds in Areas 4, 7, 9/10 and 11 and semi-volatile organic compounds (SVOCs) in Area 9/10. SVOC analytes included acenaphthene, fluorene, pyrene, and phthalate. Geoprobe soil gas and soil boring survey results were then used to locate the deep soil borings.

Geoprobe soil sampling followed the procedures outlined in the SAP (CDM 1996d) and Work Plan (CDM 1996a) unless noted otherwise. The Geoprobe piston sampler system was used according to SAP (CDM 1996d) procedure. Two soil samples from the vadose zone, the unsaturated area above the water table, were collected from each location. The first soil sample was collected at the same depth as the soil gas sample. The second sample was collected at a greater depth, closer to the water table, to further define the vertical extent of contamination.

The following list summarizes the total number of soil sample locations and corresponding sample depth ranges from each operable unit:

- Area 4: 7 locations at depths of 15 to 24 feet below ground surface (bgs);
- Area 7: 9 locations at depths of 3 to 14 feet bgs;
- Area 9/10: 38 locations at depths of 15 to 30 feet bgs; and
- Area 11: 14 locations at depths of 15 to 33 feet bgs.

Field Equipment Used

Terra-Trace used three different field vehicles, a Geoprobe truck and "Mule" and the Hurricane truck, to collect soil samples. The Geoprobe truck was the same vehicle used during the soil gas survey. The Geoprobe "Mule" consisted of a Geoprobe attached to the back of an all-terrain-vehicle (ATV). Finally, the Hurricane truck consisted of two masts, one fitted with an auger and the other a similar hydraulic probe mechanism to the Geoprobe rigs, attached to the back of a flat-bed truck. The Hurricane rig was only used to collect three samples at the end of the soil boring investigation.

Field Methods

A specific interval piston-style probe sampler was used to collect soil samples from discrete depths within the vadose zone in the study areas (CDM 1996d). The sampler contains an internal piston that was manually released upon reaching the desired sampling interval allowing soil to enter the sampling tube so it could be brought to the surface for inspection and analysis. The piston sampler was fitted with an acetate liner which was removed after the sample was collected.

A 2-foot long split-spoon sampler was used to collect the three samples while using the Hurricane rig. Drive rods were percussion hammered down to the desired sampling depth and then they were removed. The split-spoon sampler was then attached to the drive rods and driven down to collect the soil sample.

Deviations from the Proposed Work Plan and SAP

The SAP (CDM 1996d) specified that soil samples from all areas should be analyzed for TCL (Target Compound List) volatile organic compounds (VOCs). Additionally, an estimated 88 samples were to be analyzed for B/N/A (base-neutral-acids) extractables and PCBs/pesticides from Area 9/10 samples. Extra sample volume requirements in Area 9/10 (VOCs, B/N/As, and PCBs/pesticides) necessitated probing two holes per location. This extra probing doubled the sample time for each location and slowed project completion. Therefore, B/N/A extractables and PCBs/pesticides were sampled at one Area 9/10 location a day. Also, access problems inhibited the collection of all the proposed soil (and soil gas) samples in Area 9/10. Because VOCs were the primary compounds of concern and the B/N/A and PCB/pesticide screening was only intended to delineate the presence or absence of these compounds, this modification does not alter the primary objective of the survey.

Initially, Area 9/10 soil samples were collected at the same depth as soil gas samples (23 feet) and approximately five feet deeper (above the water table). However, for increased sampling efficiency, soil samples were subsequently collected at shallower depths (15-17 feet and 20-22 feet). Representative soil samples from each location were still obtained without compromising accuracy.

Decontamination

The Geoprobe rods were decontaminated after samples were collected from each location to prevent cross-contamination between boreholes. Decontamination procedure followed the steps outlined in the SAP (CDM 1996d).

2.4 Deep Soil Borings

CDM and drilling subcontractor Terracon advanced 13 of the 13 proposed deep soil borings in Areas 4, 7, 9/10 and 11 from June 25 through July 9, 1996, during the Southeast Rockford Source Control Operable Unit field investigation. These deep soil

borings were advanced in areas where soil gas and field headspace measurements indicated high VOC concentrations. The primary objectives were to determine whether NAPL (Non-Aqueous Phase Liquid) was present near the zones of highest contamination and to provide detailed stratigraphy to support remedial action evaluation.

Deep soil boring sampling followed SAP (CDM 1996d) and Work Plan (CDM 1996a) procedure, unless noted otherwise. Deep soil borings were advanced using hollow stem auger and mud-rotary drilling methods and continuous samples were collected using a split-spoon sampler. Hollow stem augering was used until the saturated zone (water table) was encountered and then mud rotary drilling was employed to inhibit borehole collapse and sand/water upheaval into the augers.

Soil samples were visually examined, screened for organic vapors with a PID (HNU Model PI-101 or Thermo Environmental Instruments OVM Model 580B) and/or FID (Foxboro OVA 128), and selected samples showing elevated levels of VOCs were field tested for NAPL. Field screening results were used to select one sample from each boring in Areas 4, 7 and 11 for TCL VOC analysis by the CLP laboratory. Two samples per boring in Area 9/10 were collected for RAS VOC and RAS metals and cyanide.

As specified in the SAP (CDM 1996d), soil borings were extended, unless otherwise noted, to 80 feet below ground surface (bgs) in each area except in Area 11, where 60 feet was the target depth. The shallower depth in Area 11 was based on previously collected data indicating the potential for LNAPL. If field screening indicated contamination at these borehole termination depths, the borehole was proposed to be advanced to bedrock (maximum expected depth 120 feet); however, PID/OVA readings did not indicate contamination at these depths and borings were not advanced to bedrock.

Soil borings SB7-201, SB7-202 and SB4-202 were terminated at 29, 27 and 65 feet below ground surface, respectively, to prevent the downward migration of free product indicated visually and by a positive result for the hydrophobic dye shaker test (with Sudan IV). The methodology used for the Sudan IV test is described below. The positive field test indicated the presence of immiscible phase product. Because a contaminated clay layer was encountered in both Area 7 boreholes, the boreholes were terminated as specified in the Work Plan (CDM 1996a) to prevent the downward migration of contaminants.

Soil borings SB11-203 and SB9/10-205 were terminated at 57 (instead of 60 feet) and 55 feet bgs (instead of 80 feet), respectively, due to the low FID readings and negative hydrophobic dye shaker test results. These termination depths, however, did not affect sample study results.

2.4.1 Dye Shaker Test for Non-Aqueous Phase Liquid

Subsurface soil samples were tested for the presence of a non-aqueous phase liquid (NAPL) using Sudan IV (CAS No. 85-83-6), a hydrophobic dye used to stain fatty animal tissue. Sudan IV works by staining only non-aqueous phases with a red color. No stain is taken if water is the only phase present. The testing procedure consisted of mixing a small amount of soil (approximately 25 grams) with 25 mL of distilled water in a sealable, clear container. The mixture was then shook and a small amount of Sudan IV (enough to fit on the head of a pin) was added, followed by additional shaking. Presence of NAPL was indicated by red-stained liquid.

2.5 Surface Water and Sediment Sampling

CDM conducted surface water and sediment sampling from the creek paralleling the northern boundary of Area 7 on June 10, 1996 during non-flood conditions. Two previous creek sampling attempts (May 20 and 23, 1996) were aborted due to heavy rainfall that caused the creek to flood. Creek surface water and sediment sampling was conducted to evaluate the potential for ecological impacts from Area 7 and the need for additional sampling. One water sample was collected at the confluence of the creek and the small valley trending south to north through Area 7. Individual upstream and downstream water samples were also collected in relation to the confluence point. Additionally, two creek sediment samples were collected at the confluence, and one sample each from upstream and downstream of this point. All creek surface water and sediment samples were analyzed for TCL organics, B/N/As, pesticides and PCBs.

Field Equipment and Methods

Creek surface water samples were collected by immersing the sample bottle in the creek until it was filled. A shovel was used to collect three sediment samples from each location which were composited in a stainless steel bowl and containerized using a stainless steel spatula.

2.6 Surface Soil Sampling

CDM collected 14 surface soil samples at the locations where soil gas results indicated the elevated presence of VOCs. Surface soil sampling occurred from June 10 to 25, 1996, during the field investigation. Surface soil samples were collected from 0 to 6 inches using a decontaminated stainless steel spatula. These samples were visually examined and field screened for VOCs using a PID or FID following the procedures outlined in the SAP (CDM 1996d). Three samples at each location were composited, placed in a stainless steel bowl for mixing and transferred into laboratory-sterilized sample jars via the spatula. VOC samples, selected visually or by screening, were grab samples. Soil samples were analyzed for TCL organics and TAL inorganics by the CLP laboratory.

2.7 Geoprobe Groundwater Screening

CDM and Geoprobe subcontractor Terra-Trace, collected groundwater screening samples on July 8 and 9, 1996, at three locations (GW9/10-201, 202 and 203) that are located at or near the newly installed monitoring well locations (MW201, 202 and 203). Groundwater samples were collected approximately every 10 feet starting at the water table (around 36 feet bgs) to a total depth of 61 feet bgs. Four samples were collected per location and shipped along with one duplicate and trip blank to the NET Laboratory in Rockford for 24 hour turnaround analysis. Groundwater screening samples were analyzed for VOCs. VOC results were then used to install the screen in the most contaminated interval.

Groundwater screening was conducted by first driving a steel probe into the subsurface using the Geoprobe method. Once the probe was at the desired depth, it was raised approximately four inches to remove the expendable drive point. Holes were drilled into a polyethylene tube (acting as a screen) which was then lowered through the Geoprobe rods. Smaller diameter tubing was inserted through the larger polyethylene tubing and attached to a peristaltic pump. Groundwater was then pumped out of the borehole and headspace readings and four samples per location (at different depths) were collected.

2.8 Monitoring Well Installation

CDM and drilling subcontractor Terracon installed three groundwater monitoring wells within and hydraulically upgradient of Area 9/10 from June 9 through 11, 1996, during the field investigation. Two monitoring wells, MW202 and MW203, were installed east of Eleventh Street across from Mid-States Industrial, Sundstrand, and Nylint (Figure 2-1). These wells were installed to further characterize groundwater flow and establish groundwater quality upgradient of Area 9/10. Monitoring well MW201 was installed in a parking lot east of Ninth Street and north of Harrison Avenue (Figure 2-1). Geoprobe soil gas and soil boring results and deep soil boring field screening indicated the presence of elevated VOC levels at the location where MW201 was subsequently installed.

The three boreholes were advanced using 4.25 inch hollow stem auger and mud rotary drilling methods. Soil samples were collected from 39 to 51 feet bgs at MW203 using the two-inch diameter 2-foot long split-barrel sampler to confirm local stratigraphy. Because a deep borehole was previously advanced at MW201, soil sampling was unnecessary.

All monitoring wells were installed according to specifications outlined in the July QAPP addendum (CDM 1996c). Following borehole completion, a two-inch diameter, ten-foot long stainless steel well screen attached to a stainless steel riser (Type 304) was inserted into each borehole through the hollow stem augers. Geoprobe groundwater screening results were used to determine the depth of screen placement. A coarse silica sand pack (#20 - #40) was placed around the well screen

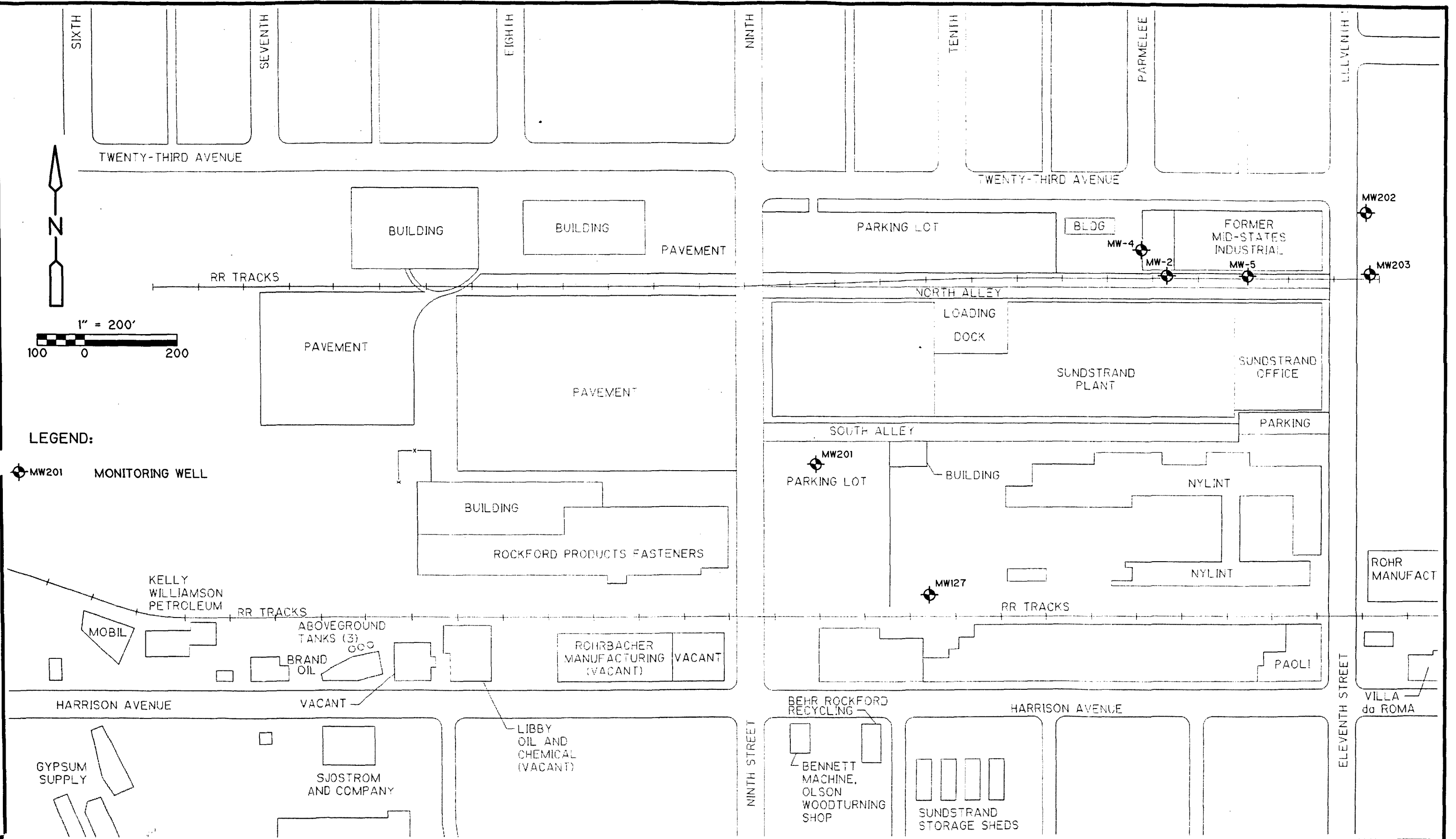
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SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
AREA 9/10 MONITORING
WELL LOCATIONS

Figure No. 2-1

(0.010 inch slot size) to one foot above the screen. A one foot fine sand (#90) was placed above the coarse sand pack. One foot of pelletized bentonite was then inserted above the fine sand. Bentonite-cement grout was tremied to two feet below grade and each well was completed with a steel flush-mounted cover cemented in place. Well construction details are outlined in the monitoring well construction logs in Appendix E.

During the construction of MW203, the casing became lodged in the augers and was pulled approximately 7 feet out of the borehole. Because the bentonite grout had already been added to the well, the screen contacted the bentonite and was compromised. Upon removal of the riser and screen, it was observed that grout had entered the casing. The borehole was abandoned, filled with bentonite grout and capped with 1-foot of concrete. A new location 5-feet east of the abandoned borehole was chosen for the placement of MW203.

Each well was developed approximately 1-day after installation to remove sediments from the well and ensure a representative groundwater sample. A Grundfos pump powered by a portable generator was used to pump and surge each well for development. The water volume, time and turbidity were noted during development. Periodically, as each well was pumped, the pump would be raised and lowered (surging) to remove any loose sediment clogging the well screen and further develop the surrounding formation. This process was repeated until the discharge water became clear after minimal elapsed time. Purge water was containerized in 55-gallon drums that were transported to the drum storage area.

The newly installed monitoring wells (MW201, 202 and 203) and three monitoring wells (MW-2, -4 and -5) on the former Mid-States Industrial property were surveyed by Missman-Stanley and Associates following completion of the field investigation. Monitoring well survey results enabled accurate water level contour mapping of the area.

Prior to groundwater sampling from the selected monitoring wells, CDM collected water level measurements at Mid-States wells MW2, 3, 4 and 5 and existing wells MW127 and MW128 to determine groundwater flow in the area. The integrity of MW-2, MW-3, MW-4, and MW-5 was confirmed.

2.9 Groundwater Sampling

CDM collected groundwater samples at MW201, 202 and 203 and Mid-States monitoring wells MW4 and MW5 to confirm previous results, establish background (upgradient) water quality, and characterize water quality at the three newly installed monitoring wells. CDM measured water levels at all sampled wells and MW123 through MW129, MW2, MW116A and MW138 to determine groundwater flow direction in the area. Groundwater samples and water level measurements were taken on July 16 and 17, 1996, as outlined in the July QAPP addendum (CDM 1996c).

A Fultz pump was used to purge between three and five well volumes prior to groundwater sampling at each well. Purge water was containerized in 55-gallon drums and transported to the drum storage area. Water quality parameters including pH, conductivity and temperature were taken with a Hydac water quality probe during purging. Groundwater samples were collected following parameter stabilization and the removal of 3 to 5 well volumes. After sampling at each location, the Fultz pump was decontaminated with an Alconox and water solution. Distilled water and ultra-pure laboratory water (distilled and deionized) was then pumped through the Fultz pump.

2.10 Data Usability

The Final Remedial Investigation Report (CDM 1995) for the Phase II activities provides a detailed discussion of the usability of the data collected for that phase of the project. The Phase II data were used to help delineate the nature and extent of contamination at the source areas and will be used to help delineate the risk assessment and feasibility study for the SCOU. The Phase II data were considered comparable with the SCOU data because the SCOU data was collected under addenda to the Phase II approved Quality Assurance Project Plan (QAPP) (CDM 1996b and 1996c). Sampling and analysis procedures are consistent between the phases of work and the Contract Laboratory Program was used for a majority of the analytical services.

The QAPP addenda detail the QA/QC measures necessary to produce useable data from field screening and analyses as well as laboratory analysis. Appendix A contains the full text of the Data Usability Evaluation. The data is evaluated to determine the degree to which the defined QA/QC measures were followed and the data usability is defined for each set of data. The main findings of the evaluation are provided below.

The field sampling program for the SCOU used four types of data acquisition methods which correspond to the first four levels of data quality objectives (DQO):

- Field screening - DQO Level 1
- Field analysis - DQO Level 2
- Non-CLP laboratory analysis - DQO Level 3
- CLP laboratory analysis - DQO Level 4

Field screening included organic vapor monitoring; pH, temperature, and conductivity measurements; and NAPL testing. Field instrument calibration and maintenance was performed according to the QAPP and was recorded in the field log books. All data collected was recorded in the log books. The field screening data collected is considered useable as reported.

Field analysis included data generated by the field gas chromatograph for the soil gas survey. A minor data gap was identified in the number of system blanks and ambient air samples collected during several days of the survey. Additionally, low levels (usually at or near the detection limit) of volatile organics, primarily toluene, ethylbenzene and xylenes were detected in both ambient air samples and system blanks. Based on the screening level use of this data, the data is considered useable as reported.

Non-CLP laboratory volatile organic analysis was conducted by NET laboratory for groundwater samples collected during drilling. Methylene chloride was detected in the trip blanks at low levels and all other required QC were within the specified limits. The non-CLP laboratory data is considered useable as reported.

CLP laboratory analysis was conducted for surface soil, subsurface soil, surface water, sediment and groundwater samples from monitoring wells during the SCOU. Rejected semivolatile data was evaluated and was not determined to be a data gap because the rejected compounds were not contaminants of concern for the site. Several instances were identified where insufficient field QC samples were collected for particular matrices and analysis parameters. These constituted minor data gap and do not affect the data usability. CLP data was determined to be useable as reported.

The goal for data usability as defined in the QAPP addenda for the SCOU was 95% of the data collected must be useable. An evaluation of all identified data gaps and unusable data constituted a loss of only two percent of the data resulting in 98% of the data being useable. Appendix A provides additional detail regarding the determination of data usability.

Section Three

Section 3

Characterization of Source Areas

3.1 Area 4

3.1.1 Description

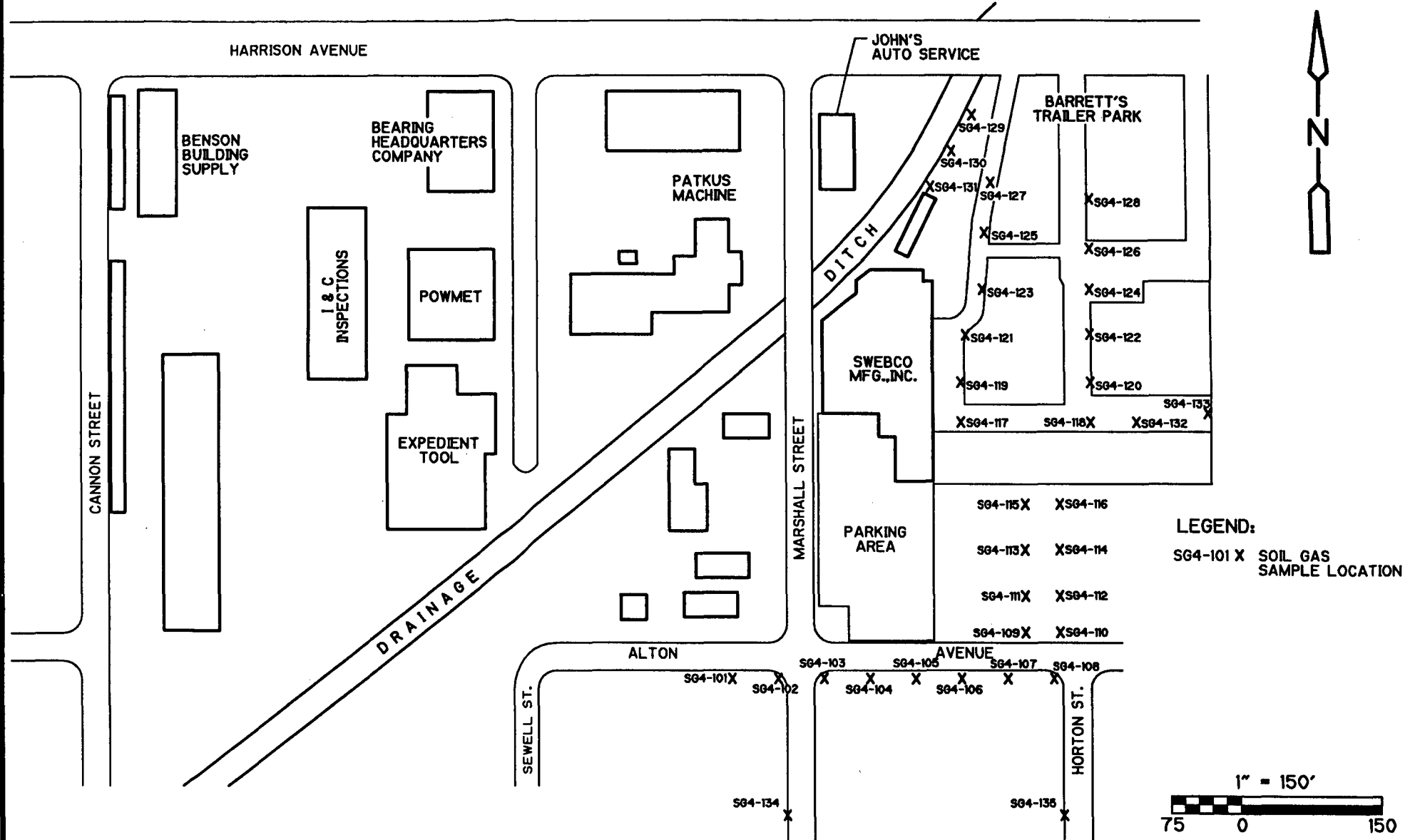
Source Area 4 is bounded by Harrison Avenue to the north, Alton Avenue to the south, and Marshall Street to the west (**Figure 3-1**). The SCOU investigation for Source Area 4 included Barrett's Trailer Park and the residential area located south and east of Swebco Manufacturing, Inc. In previous investigations (CDM, 1995), the source of the contamination from this area was determined but the full extent of contamination was not. The purpose of this investigation was to delineate the horizontal and vertical extent of contamination emanating from the source. This investigation was also used to provide detailed information for source remediation.

During past investigations, high concentrations of TCA were found in soils underneath the parking lot of Swebco Manufacturing, Inc. (2630 Marshall Street). The extent of contaminated soils determined in the RI report (CDM, 1995) is an area approximately 50 by 75 feet (long axis oriented east-west) located beneath the Swebco parking lot. The volume of highly contaminated soil was estimated to be 1,100 cubic yards (cy), with a weight of TCA at 977 pounds (lbs.), assuming a thickness of eight feet.

The release of contaminants is believed to have come from USTs located at the Swebco Manufacturing facility. The source at the area is believed to be a single source which consists mostly of TCA.

The potential pathways of contaminant migration in Source Area 4 are through both the unsaturated and saturated zones. Contaminants move downward through the void spaces in the unsaturated zone until the water table is encountered. In the saturated zone contaminant vapors move upward, away from the water table, and dissolved-phase contaminants migrate hydraulically downgradient and will volatilize into the unsaturated zone. DNAPL, if present, would migrate downward through the soil and into the saturated zone. Because DNAPL migration is controlled by subsurface structure and topography and not by hydraulic gradient, it would continue to migrate downward until an impermeable layer is encountered and then travel along the topographic slope of the layer.

Groundwater is encountered at approximately 29 feet below the ground surface in the vicinity of the source. High concentrations of TCA (1,000 µg/L) were found in one downgradient monitoring well (MW130), and in residential wells, located west of Source Area 4. Residential air sampling from area basements (west and northwest of the Swebco Facility) indicates that TCA is migrating to the basements.



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 4 SOIL GAS SAMPLE LOCATIONS

CDMenvironmental engineers, scientists,
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Figure No. 3-1

3.1.2 Results of SCOU Investigation -- Area 4

Soil Gas Results

Phase I and Phase II soil gas surveys focused on the parking lot south of the Swebco Manufacturing facility and west of Marshall Street. The SCOU investigation focused on areas to the east and south of the parking lot to find the farthest extent of contamination.

A total of 35 soil gas samples were collected from Source Area 4. Figure 3-1 shows the location of the soil gas data points. A discussion of the methods and procedures used during the soil gas survey is found in Section 2.2.

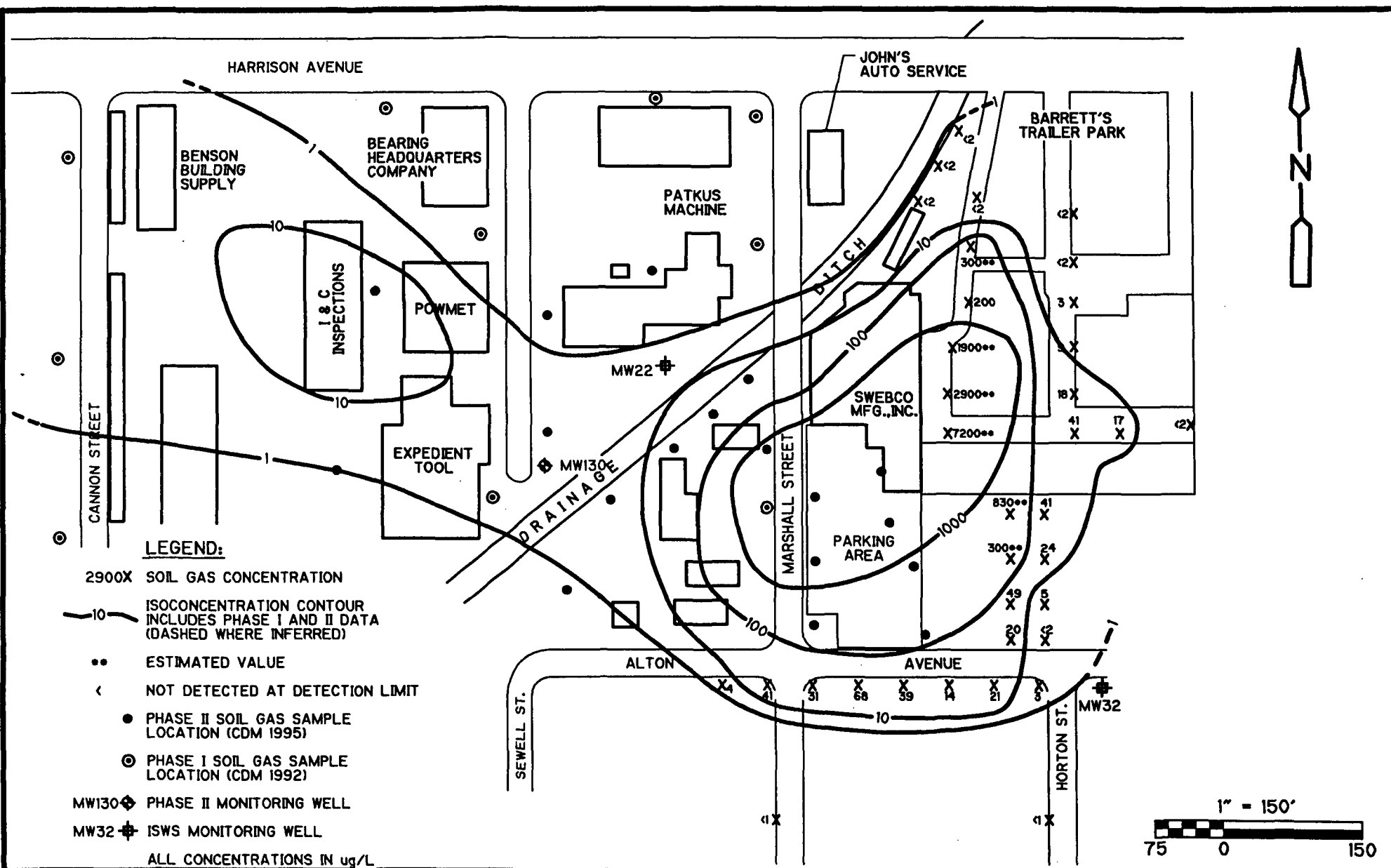
TCA was the most commonly detected compound with 25 of the 35 samples containing TCA above the quantitation limit. The highest concentration of TCA found was 7,200 µg/L at SG4-117. Soil gas points SG4-119 and 121 had concentrations of TCA at 2,900 µg/L and 1,900 µg/L, respectively. Four soil gas samples had concentrations of TCA above 100 µg/L. Figure 3-2 shows the distribution and concentration of TCA vapors. The area immediately east of the Swebco building has the highest concentration of soil gas contaminants. Soil gas locations along Alton Avenue (south of the parking lot) had concentrations of TCA less than 50 µg/L except for SG4-14 which had a concentration of 68 µg/L. Soil gas data for Area 4 are presented in Appendix B. Figure 3-3 shows the concentration of total VOCs at Source Area 4.

Soil gas samples were also analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX). Toluene was detected above quantitation limits for every soil gas point in Area 4. Soil gas points SG4-121 and 125 had concentrations of 60 µg/L and 290 µg/L, respectively. SG4-119 and 125 had concentrations of xylene at 53 µg/L and 120 µg/L, respectively. Figure 3-4 shows the distribution of BTEX compounds.

Surface Soils

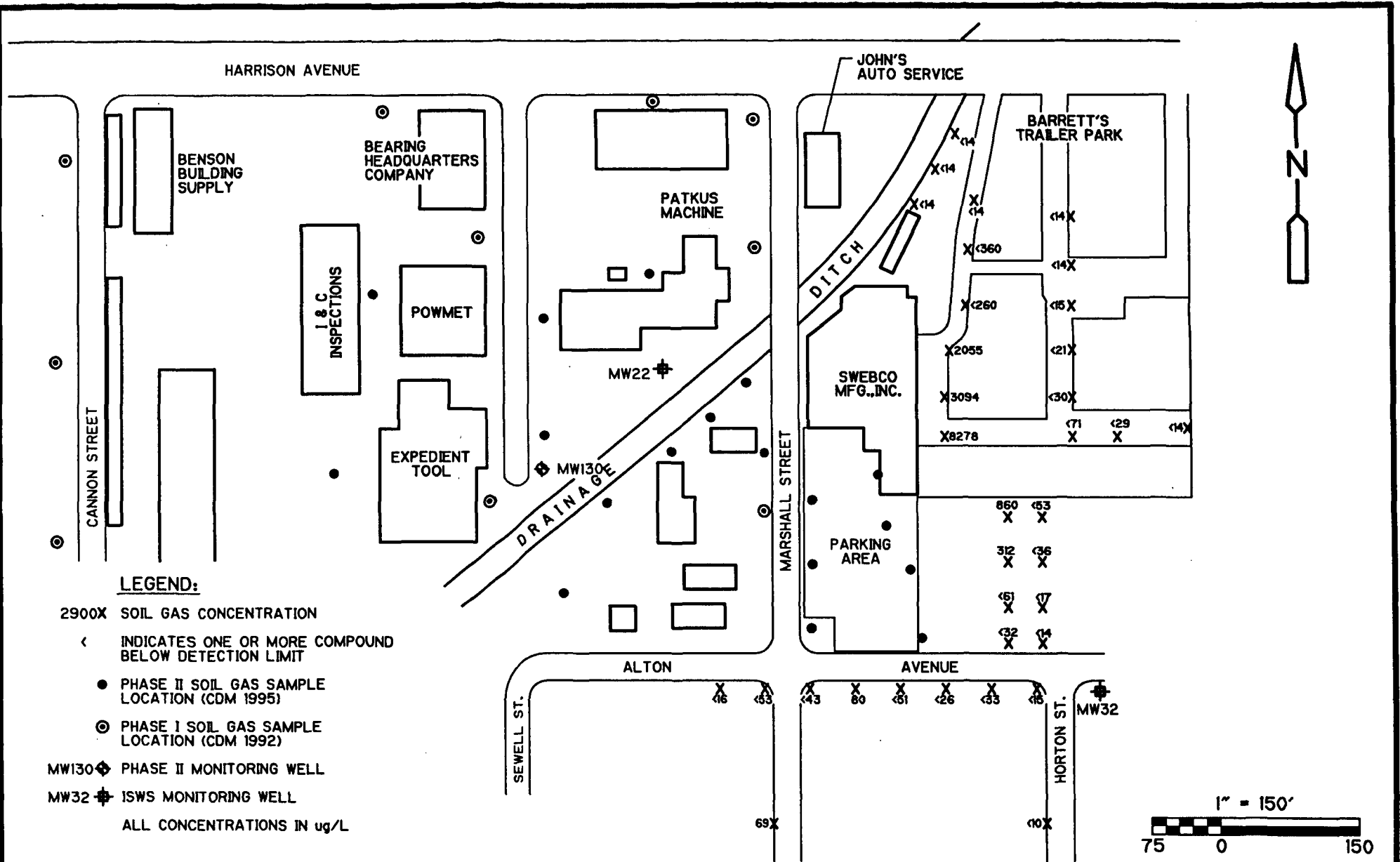
In addition to collecting soil gas and subsurface soil data, CDM also collected surface soil in Area 4 to determine the amount of surface contamination (Figure 3-5). Five surface soil and one duplicate sample were analyzed for RAS Target Compound List Organics, RAS Metals, and cyanide. Samples were collected in residential areas and were in areas where human contact with soil is likely. The depth of surface soil samples was approximately 6 to 12 inches below the ground surface.

Only one VOC was detected in the surface soil samples in Source Area 4. SS4-205 and SS4-203-D had concentrations of 2 µg/kg and 1 µg/kg of 1,2-dichloropropane, respectively. A list of detected semivolatile compounds and the range of concentrations is listed in Table 3-1.



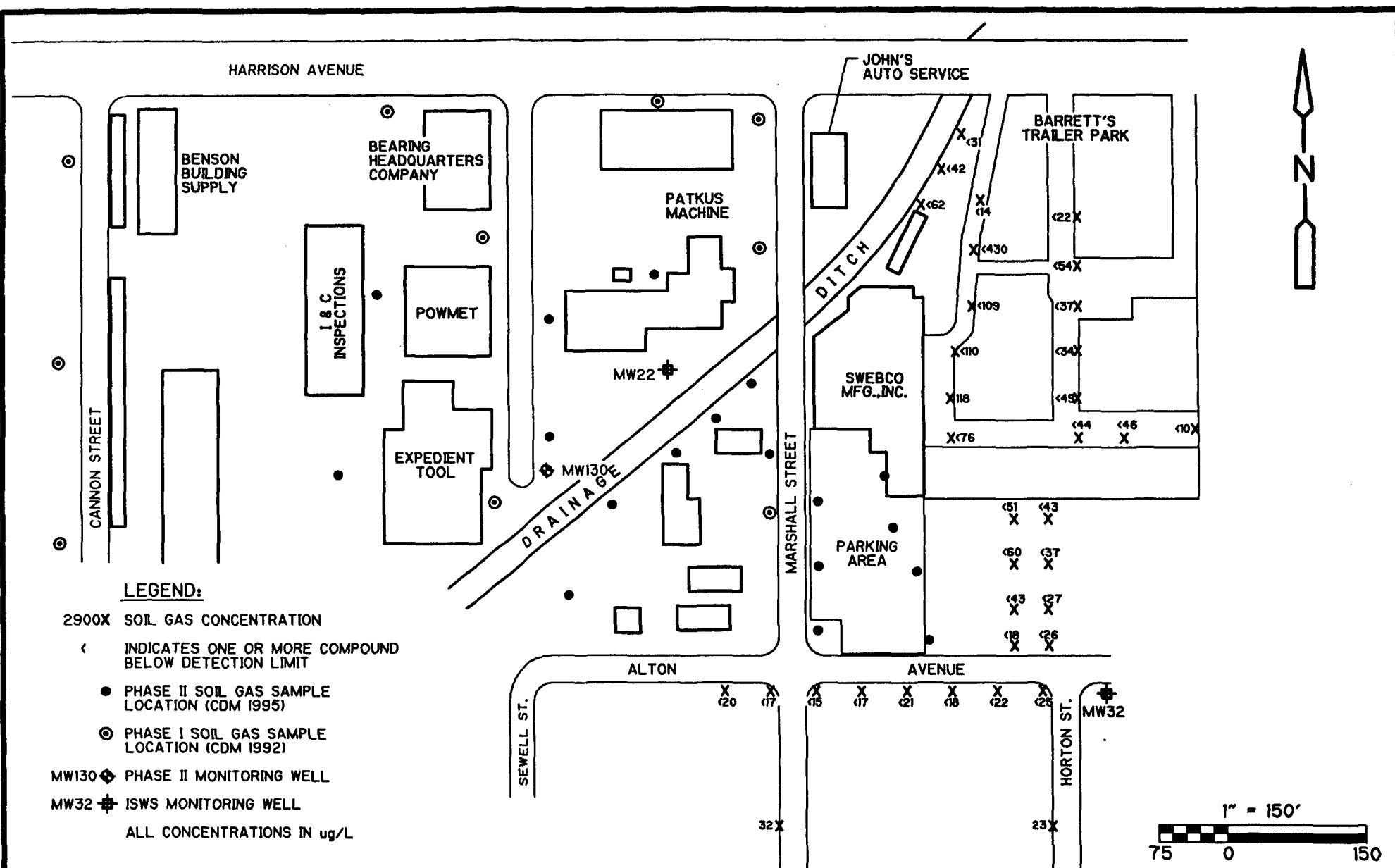
SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 4 SOIL GAS RESULTS FOR TCA



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 4 SOIL GAS RESULTS FOR TOTAL CHLORINATED VOCs



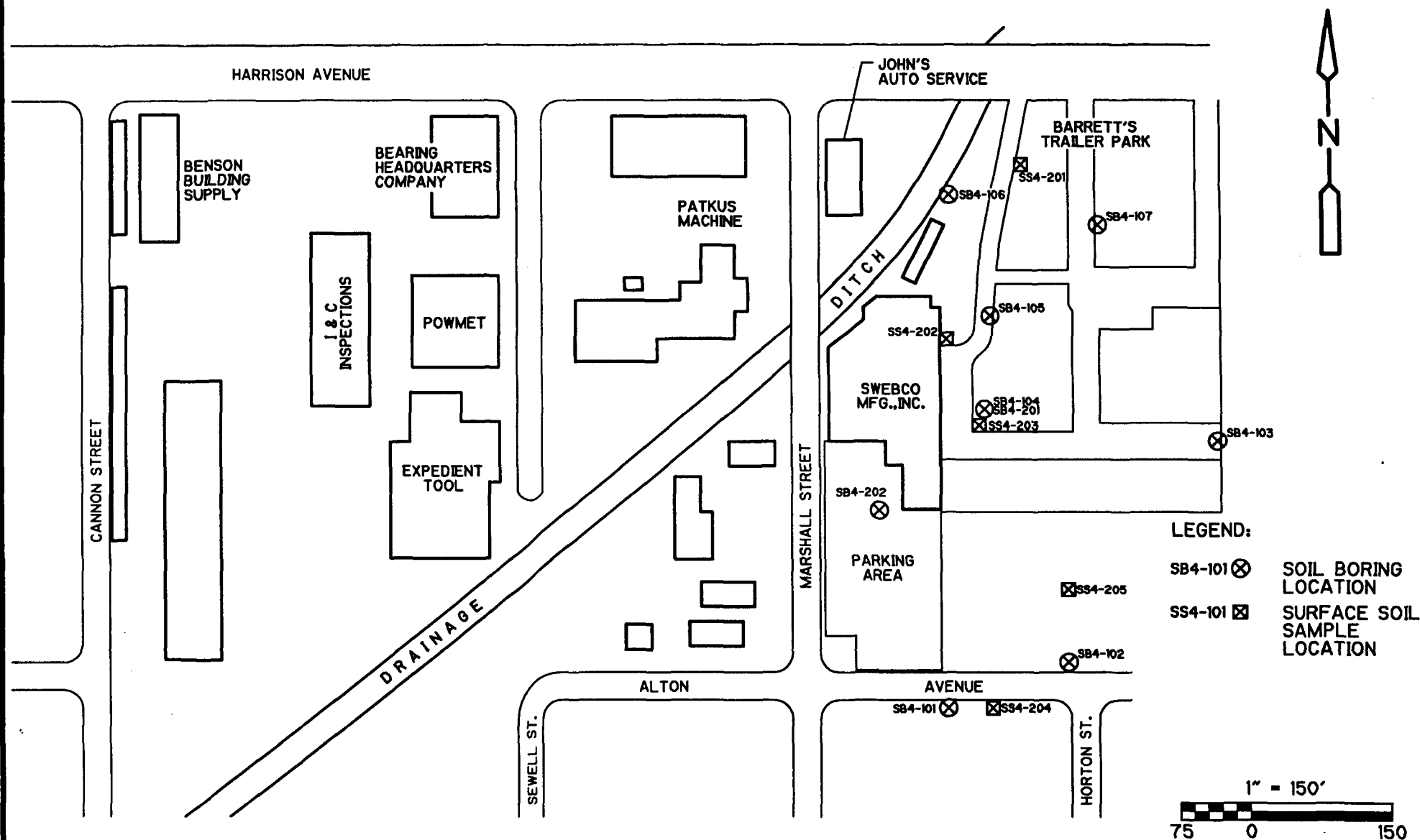
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AREA 4 SOIL GAS RESULTS FOR TOTAL BTEX

CDM

**environmental engineers, scientists,
planners, & management consultants**

Figure No. 3-4



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 4 SOIL BORING AND SURFACE SOIL SAMPLE LOCATIONS

Figure No. 3-5

Table 3-1
Southeast Rockford Groundwater Contamination Site
Rockford, Illinois

Source Control Operable Unit Investigation

Range and Frequency Of Detection Table - Organic Surface Soil Analysis - Area 4

Parameter	Organic Surface Soils - Area 4	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
1,2-Dichloropropane	1 - 2	2 / 6 (33%)
<u>Semivolatile Organics (ug/Kg)</u>		
Naphthalene	49 - 260	3 / 6 (50%)
2-Methylnaphthalene	58 - 120	3 / 6 (50%)
Acenaphthene	850 - 960	2 / 6 (33%)
Dibenzofuran	420 - 550	2 / 6 (33%)
Fluorene	720 - 920	2 / 6 (33%)
Phenanthrene	420 - 16000	4 / 6 (67%)
Anthracene	50 - 1000	4 / 6 (67%)
Carbazole	48 - 1400	4 / 6 (67%)
Di-n-Butylphthalate	51 - 100	5 / 6 (83%)
Fluoranthene	44 - 12000	6 / 6 (100%)
Pyrene	45 - 5000	5 / 6 (83%)
Butylbenzylphthalate	60 - 180	3 / 6 (50%)
Benzo(a)anthracene	53 - 5600	5 / 6 (83%)
Chrysene	72 - 5900	5 / 6 (83%)
bis(2-Ethylhexyl)Phthalate	300 - 9000	6 / 6 (100%)
Di-n-Octyl Phthalate	67 - 67	1 / 6 (17%)
Benzo (b) Fluoranthene	67 - 11000	6 / 6 (100%)
Benzo (k) Fluoranthene	70 - 11000	6 / 6 (100%)
Benzo (a) Pyrene	97 - 1100	4 / 6 (67%)
Ideno (1,2,3-cd) Pyrene	75 - 620	4 / 6 (67%)
Dibenzo (a,h) Anthracene	41 - 430	4 / 6 (67%)
Benzo (g,h,i) Perylene	56 - 70	2 / 6 (33%)
<u>Pesticides & PCBs (ug/Kg)</u>		
delta-BHC	0.095 - 0.29	3 / 6 (50%)
Aldrin	0.29 - 0.39	2 / 6 (33%)
Heptachlor epoxide	0.52 - 0.7	2 / 6 (33%)
Endosulfan I	0.13 - 0.13	1 / 6 (17%)
Dieldrin	0.29 - 3.9	5 / 6 (83%)
4,4'-DDE	0.83 - 1.3	3 / 6 (50%)
Endrin	0.61 - 0.61	1 / 6 (17%)
Endosulfan II	0.2 - 0.4	3 / 6 (50%)
4,4'-DDD	0.13 - 1.9	5 / 6 (83%)
4,4'-DDT	3.7 - 18	2 / 6 (33%)
Methoxychlor	1.2 - 26	5 / 6 (83%)
Endrin ketone	0.3 - 0.34	2 / 6 (33%)
Endrin aldehyde	0.33 - 1	3 / 6 (50%)
alpha-Chlordane	0.2 - 3.4	5 / 6 (83%)
gamma-Chlordane	1.1 - 1.1	1 / 6 (17%)
Aroclor-1254	8.4 - 49	4 / 6 (67%)

The complete list of results for surface soil sampling is in Appendix B. Fluoranthene, benzo (b) fluoranthene, benzo (k) fluoranthene, and bis (2-ethylhexyl) phthalate were detected in all six samples at concentrations of 12,000 µg/kg, 11,000 µg/kg, 11,000 µg/kg, and 9,000 µg/kg respectively. The highest concentrations were found in SS4-203-D except for the bis (2-ethylhexyl) phthalate which was found in SS4-201. Bis (2-ethylhexyl) phthalate is a common laboratory contaminant. Other PAHs were also detected in the surface soil samples. Pyrene, benzo (a) anthracene and chrysene were detected in 5 out of 6 samples. The highest concentrations of these compounds are 5,000 µg/kg, 5,600 µg/kg, and 5,900 µg/kg in samples SS4-203 and SS4-203-D.

Pesticides were detected in each of the soil samples. The most commonly detected were dieldrin, 4,4'-DDD, and methoxychlor. Aroclor-1254 was detected in SS4-210, 202, 203-D, and 205 at concentrations of 49 µg/kg, 36 µg/kg, 30 µg/kg, and 8.4 µg/kg, respectively.

Table 3-2 contains the list of detected inorganic compounds in Area 4 surface soil samples. Zinc was found at a high concentration (742 mg/kg) in SS4-201. Aluminum, copper, iron, manganese, and potassium were found at higher concentrations than found in the average range for the United States (Schacklette and Boerngen, 1984).

Subsurface Soil Results

Sixteen subsurface soil samples were collected from seven Geoprobe soil borings and two deep soil borings in Area 4. No compounds were detected in the Geoprobe soil borings. In soil boring SB4-201 the highest organic vapor readings from the split spoon samples occurred during two intervals of 5 feet to 11 feet below ground surface (bgs) and from 25 to approximately 35 feet bgs. The highest reading on the OVA reached 14 ppm. Figure 3-6 shows the VOC results for subsurface soils and Table 3-3 lists the frequency of detection; borehole logs for SB4-201 and SB4-202 are given in Appendix B.

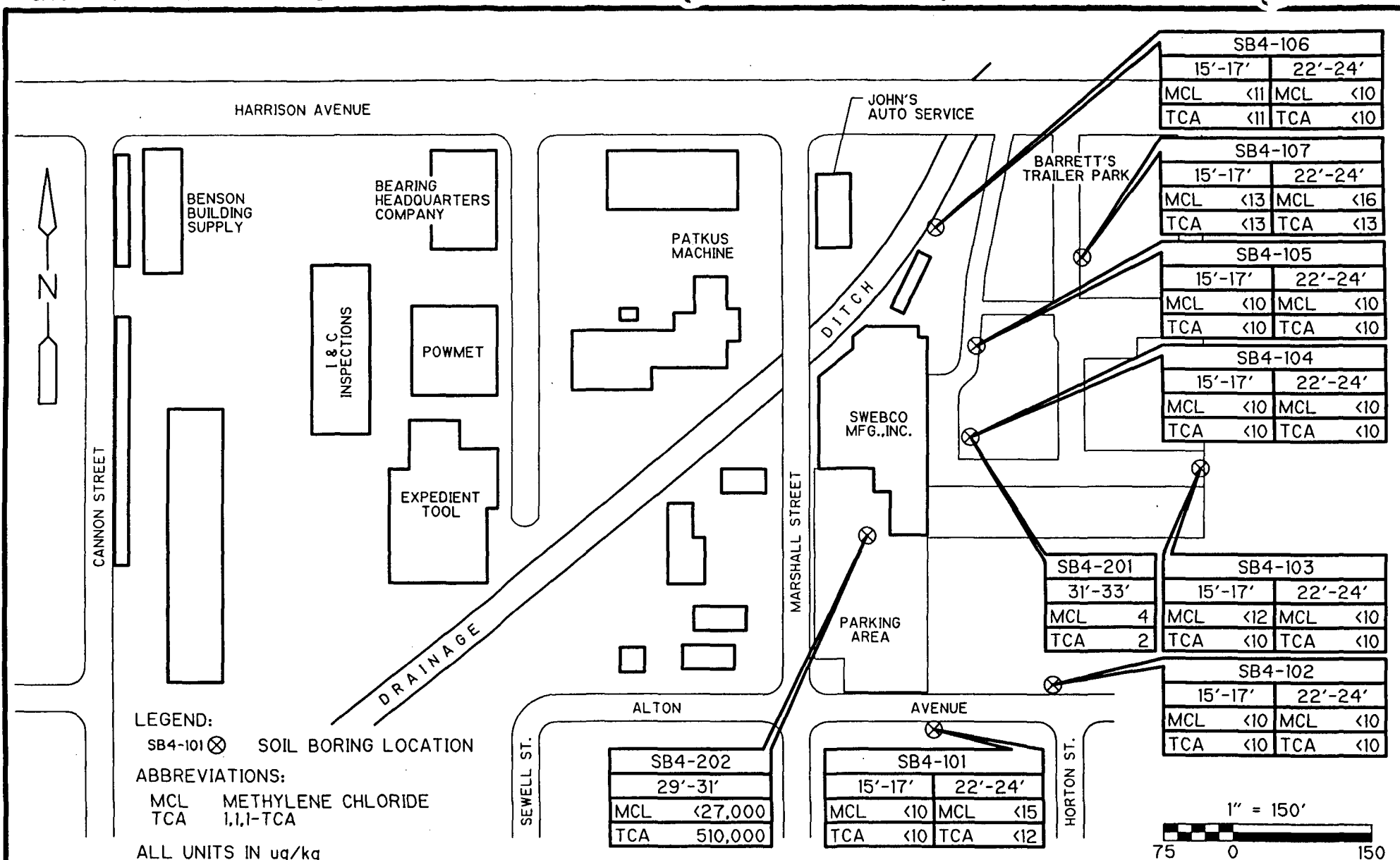
Soil boring SB4-202 had extremely high organic vapor concentrations (>1,000 ppm) at a depth of 27 to 35 feet bgs. The interval from 3 feet to 8 bgs also exhibited slightly elevated organic vapor readings (40 ppm and 52 ppm). At eighteen feet bgs the organic vapors in the soil read 71 ppm. Two samples from Source Area 4 were taken at SB4-201 and SB4-202. SB4-201 contained methylene chloride and TCA at concentrations of 4 µg/kg and 2 µg/kg, respectively. SB4-202 contained TCA at a concentration of 510,000 µg/kg. Free product was observed in this sample. A Sudan IV test was conducted on the sample to confirm if any NAPL was present. The test was positive for samples SB4-202-007 through SB4-202-011, which roughly corresponds to a depth of 27 feet to 37 feet bgs.

Table 3-2

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Inorganic Surface Soil Sample Analysis - Area 4

Parameter	Inorganic Surface Soils - Area 4	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	2550 - 8860	6 / 6 (100%)
Arsenic	2.8 - 6.2	6 / 6 (100%)
Barium	27 - 119	6 / 6 (100%)
Beryllium	0.35 - 0.7	6 / 6 (100%)
Cadmium	0.43 - 1.2	5 / 6 (83%)
Calcium	2590 - 131000	6 / 6 (100%)
Chromium	5.4 - 15.4	6 / 6 (100%)
Cobalt	2.8 - 6.2	6 / 6 (100%)
Copper	7.8 - 148	6 / 6 (100%)
Iron	7390 - 13600	6 / 6 (100%)
Lead	15.1 - 112	6 / 6 (100%)
Magnesium	1530 - 83700	6 / 6 (100%)
Manganese	264 - 592	6 / 6 (100%)
Nickel	6.8 - 13.8	6 / 6 (100%)
Potassium	296 - 856	6 / 6 (100%)
Selenium	0.92 - 1.1	3 / 6 (50%)
Sodium	70.8 - 279	6 / 6 (100%)
Thallium	1.3 - 2.4	6 / 6 (100%)
Vanadium	9.9 - 26.1	6 / 6 (100%)
Zinc	34 - 742	6 / 6 (100%)
Cyanide	0.23 - 0.46	3 / 6 (50%)



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 4 SUBSURFACE SOIL DATA FOR VOCs

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Figure No. 3-6

Table 3-3

Southeast Rockford Groundwater Contamination Site
Rockford Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Sub-surface Soil Boring Sample Analysis - Area 4

Parameter	Organic Soil Boring Samples - Area 4	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
Methylene Chloride	4 - 4	1 / 17 (6%)
1,1,1-Trichloroethane	2 - 510000	2 / 17 (12%)

3.1.3 Discussion -- Area 4

Soil gas results from this investigation are similar to the Phase I and Phase II investigations. The same trend was observed in that there were high concentrations of TCA, moderate concentrations of TCE, and low concentrations of PCE.

One Phase I soil gas sample showed elevated levels of TCA. Phase II soil gas locations were concentrated around this location to determine the extent of contamination. The soil gas samples from both Phase I and II were located at the northern end of the parking lot. The areas west and northwest of the parking lot had concentrations of TCA less than 50 µg/L.

TCA was detected in the soil gas on the east side of the Swebco Manufacturing facility, at higher levels than in any other areas during the SCOU investigation. This is hydraulically upgradient of the suspected source area. Soil gas and soil boring results indicate that the soil gas is migrating to areas where pavement is absent. The impermeable pavement directly above the source and on the surrounding areas prevents the soil gas from migrating to the atmosphere. Therefore, the soil gas moves laterally to areas where it can escape. Thus, the large soil gas concentrations immediately east of Swebco represent the lateral migration of VOC vapors from the Swebco property to Barrett's Trailer Park.

The additional analysis of BTEX compounds (commonly found in waste oils) indicates the presence of petroleum based products in Source Area 4. The highest concentrations of these compounds were found at SG4-125, located northeast of the source in Area 4. The presence of these compounds could be due to dumping of waste oils directly onto the ground nearby, resulting in organic vapor migration through the subsurface void spaces. However, it is more likely that the source of contamination is a mixture of solvents and petroleum based compounds.

Based on the soil gas results, the extent of soil gas migration to the east of the source is approximately 150 to 200 feet and does not extend to the north. Soil gas locations SG4-101 through SG4-108 have low contaminant concentrations. These points are directly south of the source and are located in unpaved areas.

Surface soil samples were taken during the Phase II investigation. These samples were taken south and west of the parking lot. Larger amounts of VOCs were detected during the Phase II investigation as compared to the SCOU investigation. Similar amounts of PAHs and inorganics were detected in both rounds of sampling. Pesticides were found during both rounds also.

The surface soil sample exhibiting the highest amount of contamination, primarily PAHs, was located at the southeast corner of the Swebco building (SS4-203). The PAHs with the highest concentrations included fluoranthene, benzo(k)fluoranthene, benzo(b)fluoranthene, phenanthrene, chrysene, and pyrene.

Contamination due to PAHs is likely due to the air emissions coming from vehicles and due to dumping of oil based products directly onto the ground. Detections of pesticides are likely due to the application of these products at homes and commercial establishments for weed and pest control. The metals could be a result of dust from local metal working facilities.

Soil boring locations were located in areas to confirm soil gas results and to help delineate the area of contamination. Phase II soil boring results from the northern parking lot of Swebco Manufacturing showed the presence of an oily product in the saturated zone. The highest contaminated zone was from 28 to 36 feet at SB4-6.

During the SCOU investigation, Geoprobe soil borings did not detect any compounds. These soil borings were located in the areas where high contaminant concentrations were detected during the soil gas investigation. No contaminants were observed in any of the samples located east (Barrette's Trailer Park) and south (residential area) of the source. SB4-101 was collected on the south edge of Alton Avenue about 5 feet from the paved road. The high concentrations in the soil gas samples are due to the migration of organic vapors in the subsurface. The absence of soil contaminants confirms that although organic vapors are moving laterally through the unsaturated zone to reach areas where the vapors can escape to the atmosphere, no Area 4 source materials are present in the trailer park.

Two deep soil borings were drilled in Area 4 to confirm soil gas results and to determine the extent of contamination. SB4-201, which was drilled at the same location (directly east of the Swebco building) as SB4-104 and SG4-117, did not contain detectable amounts of contamination. This supports the idea that the source of contamination is not present in the northeastern part of Source Area 4. SB4-202 was located in the northern part of the parking lot. This soil boring tested positive for NAPL, using the Sudan IV dye test, right above and within the top portion of the saturated zone. It contained 510,000 µg/kg of TCA at a depth of 29 feet which is at the top of the saturated zone. NAPL is present at the source area from 27 feet to 35 feet bgs. Based on the SCOU investigation results, the vertical extent of NAPL is approximately 8 feet. In the deeper portions of the soil boring, no NAPL was observed.

PAHs were also found in Source Area 4. The contamination at the Source Area 4 is probably a mixture of petroleum based products and solvents. The mixture of PAHs and TCA would probably be close to the density of water, explaining the observed product at the interface between the saturated and unsaturated (vadose) zones.

The results of the SCOU investigation for Source Area 4 confirm that LNAPL is present at the source, based on positive results for the Sudan IV dye tests. The area of contamination is approximately 3,800 ft² (50 x 75 feet). Using eight feet for contaminant thickness, the estimated total volume of contamination is 30,000 ft³ (1,100 cubic yards). The contamination does not extend farther north, south or east of the parking lot based on soil gas and soil boring data. In past investigations (CDM 1995)

wells downgradient of the source contained TCA concentrations indicating migration through groundwater.

3.2 Area 7

3.2.1 Description

Area 7 is located at the east terminus of Balsam Lane and encompasses a city park (Ekberg Park) and open farm fields containing wooded areas. Ekberg Park consists of paved basketball and tennis courts, a children's playground and park, and lawn areas. Open field and wooded areas exist south of the park on a hillside which slopes to the north. Two small valleys, which merge at the base of the hill, drain surface runoff northward and through the park with discharge to an unnamed creek bordering the north side of Area 7. Open farm field separates the north side of Ekberg Park and the creek. The site investigation history of Area 7 is summarized in Section 1 of this report.

The stratigraphy of Area 7 consists of a heterogeneous assemblage of unconsolidated sands, silts, and clays that overlie dolomite bedrock. An east-west trending, buried bedrock valley roughly parallels the present-day creek valley. Depth to bedrock varies from 35 feet on the valley flank to over 135 feet in the valley center. Groundwater flow in both the unconsolidated and bedrock aquifers is to the northwest, with localized discharge of shallow groundwater to the creek. Depth to groundwater ranges from 36 feet (MW135) south of the park, to 13 feet (MW134) within the park, to less than 2 feet (MW105) near the creek. Details of the Area 7 geology and hydrogeology are presented in the Final Remediation Investigation Report (CDM 1995).

3.2.2 Results of SCOU Investigation -- Area 7

The purpose of the SCOU investigation in Area 7 was to delineate the extent of soil VOC contamination along the north, northwest, and southwest boundaries of the area, which had been previously investigated during Phases I and II (CDM, 1995) but not completely defined. In addition, samples of surface soil, creek sediment, and creek water were analyzed to complement the subsurface investigation. Results of the SCOU investigation have defined the extent of contamination in the previously undefined areas located to the north and northwest of Ekberg Park, as well as in the southwest corner of Area 7. In addition, low concentrations of VOCs were found in creek water samples.

Soil Gas

The soil gas and headspace vapor results in Area 7 show that VOCs extend approximately 250 feet north and northwest of the children's playground located on the north side of Ekberg Park, roughly paralleling the small valley that feeds the creek along the northern limit of Area 7. Significant levels of VOCs (greater than 1,000

µg/L) were found about 100 to 150 feet on either side of the small drainage valley. No VOCs were detected in samples SG7-122 and -123 in the southwest corner.

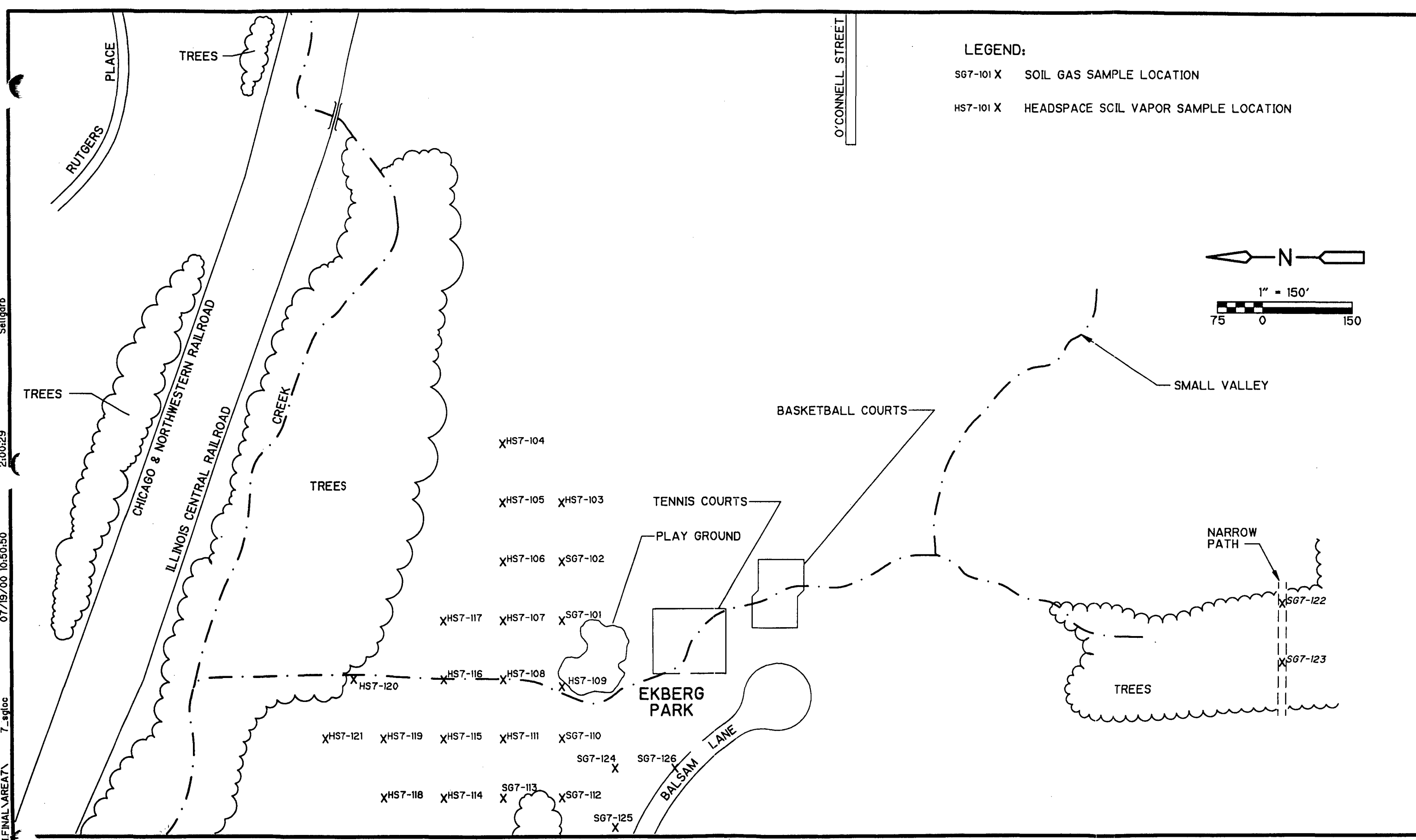
Figures 3-7 and 3-8 show the sample locations and soil gas results (sum of TCA, TCE and PCE), respectively. Note that Figure 3-2 shows soil gas results obtained from the on-site gas chromatograph and headspace values obtained with a flame ionization detector (FID). Saturated soils at shallow depths prevented the collection of soil gas at every sample location in Area 7; therefore, headspace vapor concentrations from subsurface soil samples were used in place of soil gas values at these locations. Although the headspace concentrations likely overestimate the levels of TCA, TCE and PCE in the samples because more than these three VOCs are detected by the FID and because the samples were heated prior to measurement, the headspace values are considered valid for the general delineation of the extent of contamination (i.e. screening level). Moreover, using the sum of TCA, TCE, and PCE allows for meaningful comparison with the Phase I and II soil gas surveys. Appendix C contains all of the soil gas and headspace vapor results for Area 7. Methods and procedures used during the soil gas survey and headspace measurements are given in Section 2 of this report.

Subsurface Soil

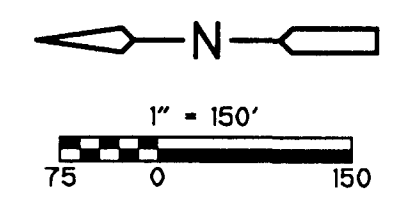
Results of SCOU soil sampling in Area 7 indicate that significant concentrations of VOCs extend northward from the north end of Ekberg Park for a distance of approximately 150 feet. The vertical extent of contamination extends to a depth of at least 27 to 29 feet in the northern part of the park (SB7-201), and to a depth of at least 27 feet in the open field located north of the park (SB7-202). Non-aqueous phase liquid (NAPL) was found in the 25 to 27 foot interval at SB7-201. VOC contamination was not found in the southwest corner of Area 7. No VOCs were detected in 5 of the 11 soil borings (SB7-101, -104, -106, -108, and -109) drilled in Area 7 during the SCOU investigation; low total VOC concentrations (< 10 µg/kg) were found in three of the borings (SB7-102, -103, and -105); boring SB7-107 contained 109 µg/kg of total VOCs; and SB7-201 and -202 had significantly large levels of contamination, 875,000 µg/kg and 18,000 µg/kg of total VOCs, respectively. Soil boring locations are shown on Figure 3-9. Table 3-4 lists the frequency of detection of VOCs in subsurface soils.

Soil analytical results for SB7-201 and SB7-202 indicate an area of high VOC contamination along the north boundary of Ekberg Park. The north boundary of the park lies approximately half way between SB7-201 and -202. The soil sample from SB7-201 had 875,000 µg/kg of total VOCs detected and the sample from SB7-202 had 18,000 µg/kg (Figure 3-10). In the western portion of the park, SB7-107 contained 109 µg/kg of total VOCs, primarily TCA, 1,2-DCE, and xylene. PCE, TCE, TCA, and 1,2-DCE were the most abundant and frequently detected chlorinated VOCs, along with the non-chlorinated VOCs toluene, ethylbenzene, and xylene. Benzene was detected in SB7-201 at a concentration of 220 µg/kg. Semi-volatile organic compounds, pesticides/PCBs, and inorganic analytes (metals and cyanide) were not analyzed

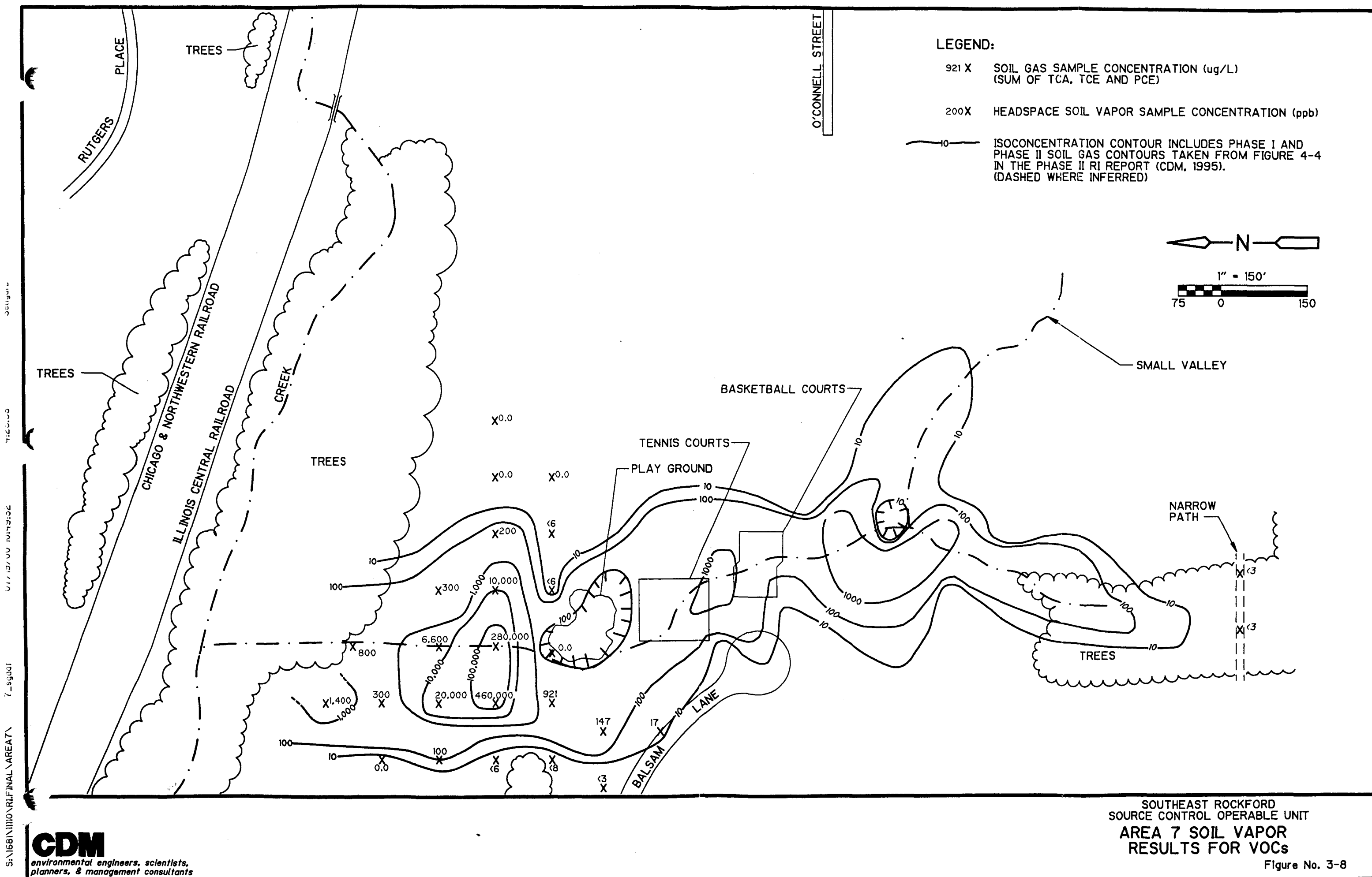
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LEGEND:
SG7-101 X SOIL GAS SAMPLE LOCATION
HS7-101 X HEADSPACE SOIL VAPOR SAMPLE LOCATION



SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
**AREA 7 SOIL VAPOR
SAMPLE LOCATIONS**
Figure No. 3-7



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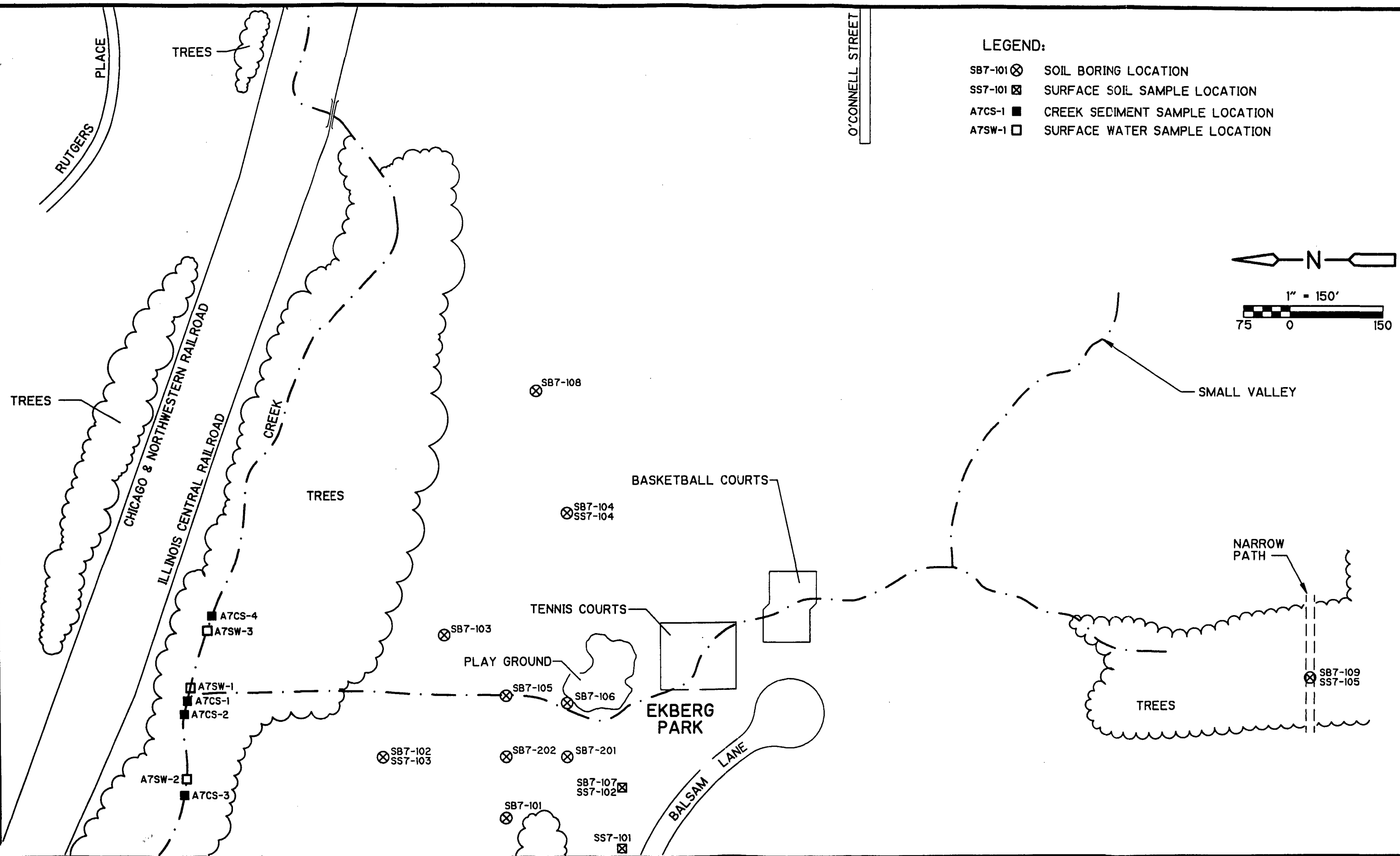
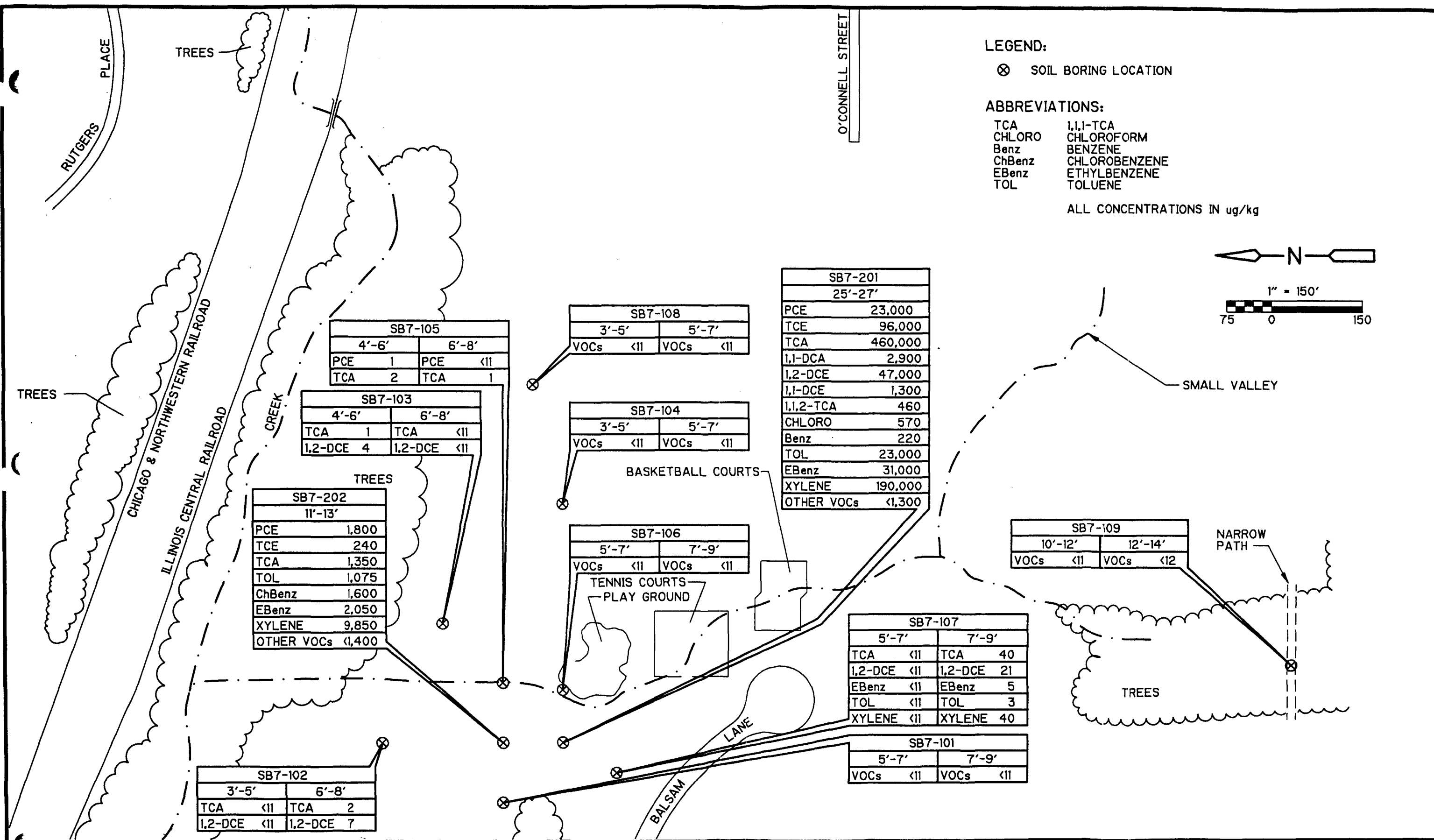


Table 3-4

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Sub-surface Soil Boring Sample Analysis - Area 7

Parameter	Organic Soil Boring Samples - Area 7	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
1,1-Dichloroethene	1300 - 1300	1 / 21 (5%)
1,1-Dichloroethane	2900 - 2900	1 / 21 (5%)
1,2-Dichloroethene (total)	4 - 47000	4 / 21 (19%)
Chloroform	570 - 570	1 / 21 (5%)
1,1,1-Trichloroethane	1 - 460000	8 / 21 (38%)
Trichloroethene	240 - 96000	2 / 21 (10%)
1,1,2-Trichloroethane	460 - 460	1 / 21 (5%)
Benzene	220 - 220	1 / 21 (5%)
4-Methyl-2-Pentanone	9 - 9	1 / 21 (5%)
Tetrachloroethene	1 - 23000	5 / 21 (24%)
Toluene	3 - 23000	4 / 21 (19%)
Chlorobenzene	1600 - 1600	1 / 21 (5%)
Ethylbenzene	5 - 31000	4 / 21 (19%)
Xylene	40 - 190000	4 / 21 (19%)



SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
AREA 7 SUBSURFACE SOIL
DATA FOR VOCs
Figure No. 3-10

during the SCOU investigation in Area 7 because only VOCs were of concern in the subsurface soils.

Non-aqueous phase liquid was visually observed at a depth of 25 to 27 feet in SB7-201, corresponding to a depth of 10 to 12 feet below the water table. The Sudan IV dye shaker test confirmed that NAPL was present in this sample. The NAPL appeared as a dark brown, immiscible, oily liquid that had a very strong solvent-like odor and a visible oily sheen. No NAPL was observed in SB7-202; however, high headspace (> 100 ppm) readings were noted for the depth interval 7 to 17 feet below grade. In SB7-201, high headspace values (> 100 ppm) were observed from 11 to 29 feet below grade. Soil borings SB7-201 and -202 were terminated when a contaminated clay layer greater than 1-foot thick was encountered, as specified in the Work Plan (CDM 1996). Termination depths were 29 and 27 feet for SB7-201 and SB7-202, respectively. The procedure used for the Sudan IV dye shaker test is given in Section 2 of this report.

Surface Soil

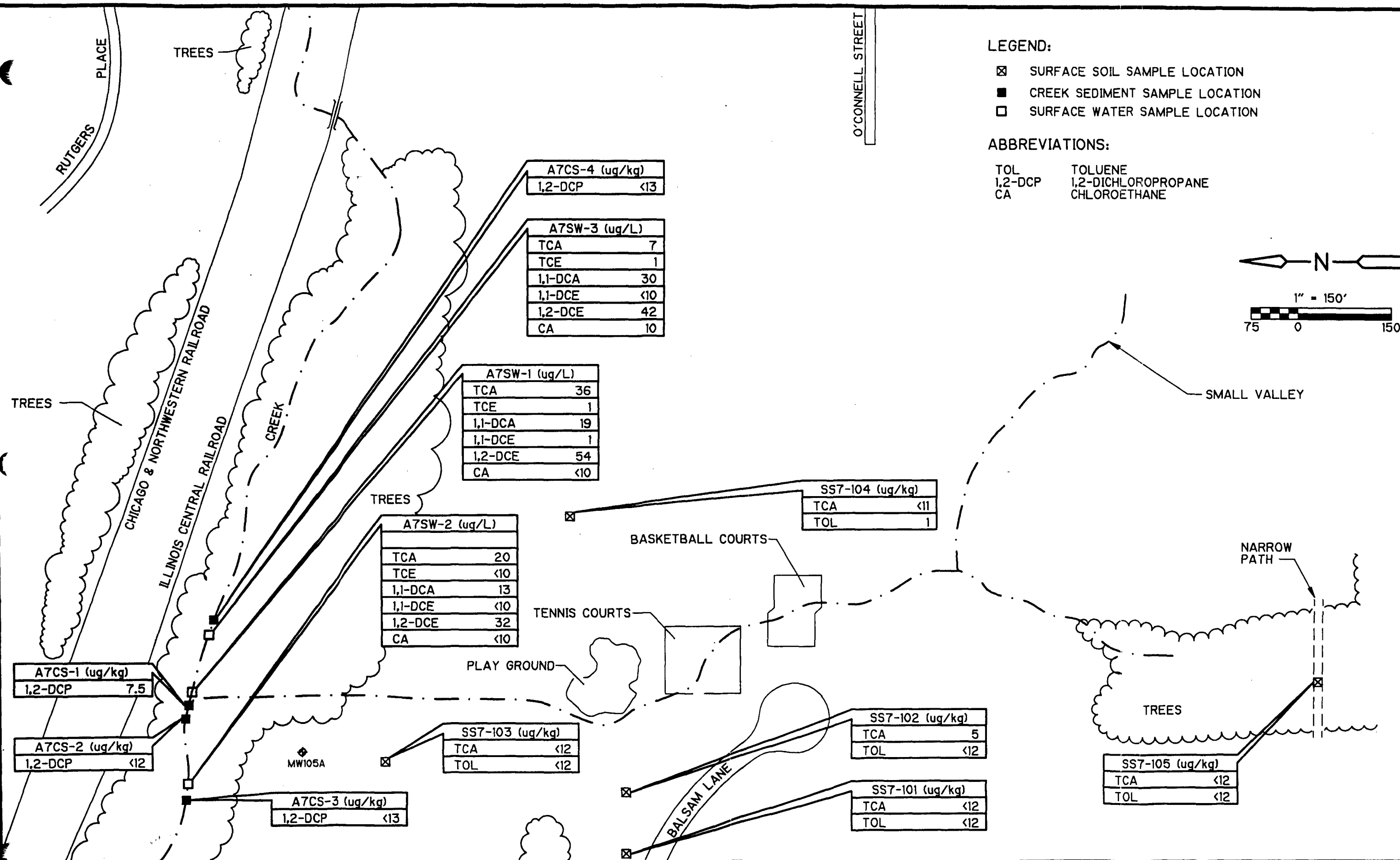
A total of five surface soil samples were collected in Area 7 and only two VOC hits were observed. Sample SS7-102 had 5 µg/kg of TCA and sample SS7-104 had 1 µg/kg of toluene (Figure 3-11). Both SS7-102 and -104 were collected from the grassy areas of Ekberg Park. The only spatial pattern to the surface soil samples is that the highest VOC concentration (5 µg/kg of TCA in SS7-102) occurred within Ekberg Park, in the general vicinity of significant subsurface soil contamination. The remaining samples contained VOCs below the detection limit, typically 12 µg/kg. Tables 3-5 and 3-6 list the frequency of detection for organic and inorganic analytes in the surface soil samples, respectively. Surface soil samples were taken between 6 and 12 inches below ground surface. The procedure used to collect the surface soil samples is described in Section 2 of this report.

Bis(2-ethylhexyl) phthalate, a common laboratory contaminant, was the only semi-volatile organic compound (SVOC) detected in the surface soil samples and no pesticides or PCBs were detected; concentrations of bis(2-ethylhexyl) phthalate ranged from 46 to 77 µg/kg. Metal concentrations for Area 7 surface soils fell within the range observed for the eastern United States (Shacklette and Boerngen, 1984), and were comparable to the observed mean values. Cyanide concentrations varied from 250 to 370 µg/kg; however, every sample had "J" and "B" data qualifiers, signifying that the values were estimated and that blank contamination was found, respectively.

Creek Sediment

The only VOC detected in the four creek sediment samples was 1,2-dichloropropane (1,2-DCP). Sample A7CS-1 had 7.5 µg/kg of 1,2-DCP (Figure 3-11), which represent the mean concentration for the sample and sample duplicate collected at this location. Two of the creek sediment samples (A7CS-1 and A7CS-2) were collected at the confluence of the creek and the small valley that runs through Ekberg Park;

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SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
AREA 7 SURFACE SOIL AND CREEK
SAMPLE DATA FOR VOCs

Figure No. 3-11

Table 3-5

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Surface Soil Analysis - Area 7

Parameter	Organic Surface Soils - Area 7	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
1,1,1-Trichloroethane	5 - 5	1 / 5 (20%)
Toluene	1 - 1	1 / 5 (20%)
<u>Semivolatile Organics (ug/Kg)</u>		
bis(2-Ethylhexyl)Phthalate	46 - 77	5 / 5 (100%)
<u>Pesticides & PCBs (ug/Kg)</u>		
No Hits		

Table 3-6

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Inorganic Surface Soil Sample Analysis - Area 7

Parameter	Inorganic Surface Soils - Area 7	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	8630 - 15000	5 / 5 (100%)
Arsenic	3.6 - 6.8	5 / 5 (100%)
Barium	41.6 - 114	5 / 5 (100%)
Beryllium	0.13 - 0.66	5 / 5 (100%)
Calcium	929 - 9400	5 / 5 (100%)
Chromium	10.1 - 17.8	5 / 5 (100%)
Cobalt	5.2 - 9.2	5 / 5 (100%)
Copper	7.6 - 15.3	5 / 5 (100%)
Iron	10600 - 19200	5 / 5 (100%)
Lead	10.9 - 22.3	5 / 5 (100%)
Magnesium	1400 - 6130	5 / 5 (100%)
Manganese	292 - 698	5 / 5 (100%)
Mercury	0.06 - 0.06	1 / 5 (20%)
Nickel	7.3 - 14.4	5 / 5 (100%)
Potassium	800 - 1270	5 / 5 (100%)
Selenium	0.98 - 0.98	1 / 5 (20%)
Sodium	26.7 - 37.7	5 / 5 (100%)
Vanadium	19.2 - 32.5	5 / 5 (100%)
Zinc	31.3 - 54.1	5 / 5 (100%)
Cyanide	0.25 - 0.37	5 / 5 (100%)

one sample was taken upstream (A7CS-4) of the confluence and one downstream (A7CS-3). There is no discernible spatial pattern for the creek sediment results.

Several SVOCs were detected in every creek sediment sample: fluoranthene, pyrene, benzo(a)anthracene, and chrysene. In addition, bis(2-ethylhexyl) phthalate, a common laboratory contaminant, was detected in every sample. Pesticides and PCBs were also found in the creek sediment samples. Frequency of detection for the creek sediment samples is given on Table 3-7. Complete results of the chemical analyses are given in Appendix C.

Creek Water

Six VOCs were detected in the three surface water samples collected from the creek running along the north edge of Area 7, as shown on Figure 3-11. The detected VOCs include TCA, TCE, 1,1-DCA, 1,1-DCE, 1,2-DCE, and chloroethane. Creek samples were collected upstream, downstream, and at the confluence of the creek and small valley. There is no discernible pattern in the spatial distribution of TCE and 1,1-DCE in the creek water samples. The greatest concentration of TCA (36 µg/L), 1,2-DCE (54 µg/L), and total VOCs (111 µg/L) was found in the sample collected near the confluence (A7SW-1), while the upstream sample (A7SW-3) contained the largest levels of 1,1-DCA and chloroethane. The downstream sample (A7SW-2) had the smallest concentrations of 1,1-DCA (13 µg/L), 1,2-DCE (32 µg/L), and total VOCs (65 µg/L); concentration values shown for sample A7SW-2 on Figure 3-5 represent the mean for the sample and sample duplicate. The smallest concentration of TCA (7 µg/L) was found in the upstream sample.

SVOCs and pesticides/PCBs were detected in the surface water samples; however, these data were qualified as estimated values. Frequency of detection for the creek water samples is given on Table 3-8. Complete results of the chemical analyses are given in Appendix C.

3.2.3 Discussion -- Area 7

The main findings of the SCOU investigation are that VOCs from Area 7 soils appear to be impacting surface water quality in the adjacent creek, that a VOC soil "hot spot" exists in and next to Ekberg Park in the northern portion of the area, and that non-aqueous phase liquid (NAPL) is present below the water table in the park. VOC concentrations in soil samples collected during the SCOU and Phase II RI investigations suggest that there is an estimated volume of 265,000 yd³ of highly contaminated soil in Area 7, which is slightly larger than the Phase II estimate (refer to Section 4.5.1.3 in CDM, 1995) because of the inclusion of the northern hot spot.

The impact of Area 7 soils on the creek is supported by the similarity of VOCs found in the creek water samples with those present in subsurface soil and in shallow groundwater samples. All six VOCs detected in creek water are also present in

Table 3-7

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Creek Sediment Sample Analysis - Area 7

Parameter	Organic Creek Sediment Samples - Area 7	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
1,2-Dichloropropane	2 - 13	2 / 5 (40%)
<u>Semivolatile Organics (ug/Kg)</u>		
Phenanthrene	56 - 240	4 / 5 (80%)
Fluoranthene	92 - 590	5 / 5 (100%)
Pyrene	42 - 140	5 / 5 (100%)
Benzo(a)anthracene	38 - 230	5 / 5 (100%)
Chrysene	44 - 270	5 / 5 (100%)
bis(2-Ethylhexyl)Phthalate	140 - 430	5 / 5 (100%)
Benzo (b) Fluoranthene	94 - 510	5 / 5 (100%)
Benzo (k) Fluoranthene	99 - 540	5 / 5 (100%)
Benzo (a) Pyrene	54 - 54	1 / 5 (20%)
	54 - 54	1 / 6 (17%)
<u>Pesticides & PCBs (ug/Kg)</u>		
delta-BHC	0.29 - 1.2	5 / 5 (100%)
Aldrin	0.37 - 0.37	1 / 5 (20%)
Dieldrin	0.21 - 0.38	5 / 5 (100%)
4,4'-DDE	0.22 - 0.4	4 / 5 (80%)
Endosulfan II	0.3 - 0.31	2 / 5 (40%)
4,4'-DDD	0.37 - 1.9	5 / 5 (100%)
Methoxychlor	0.76 - 4.6	5 / 5 (100%)
alpha-Chlordane	0.21 - 0.53	5 / 5 (100%)
Aroclor-1254	23 - 56	4 / 5 (80%)

Table 3-8

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Surface Water Sample Analysis - Area 7

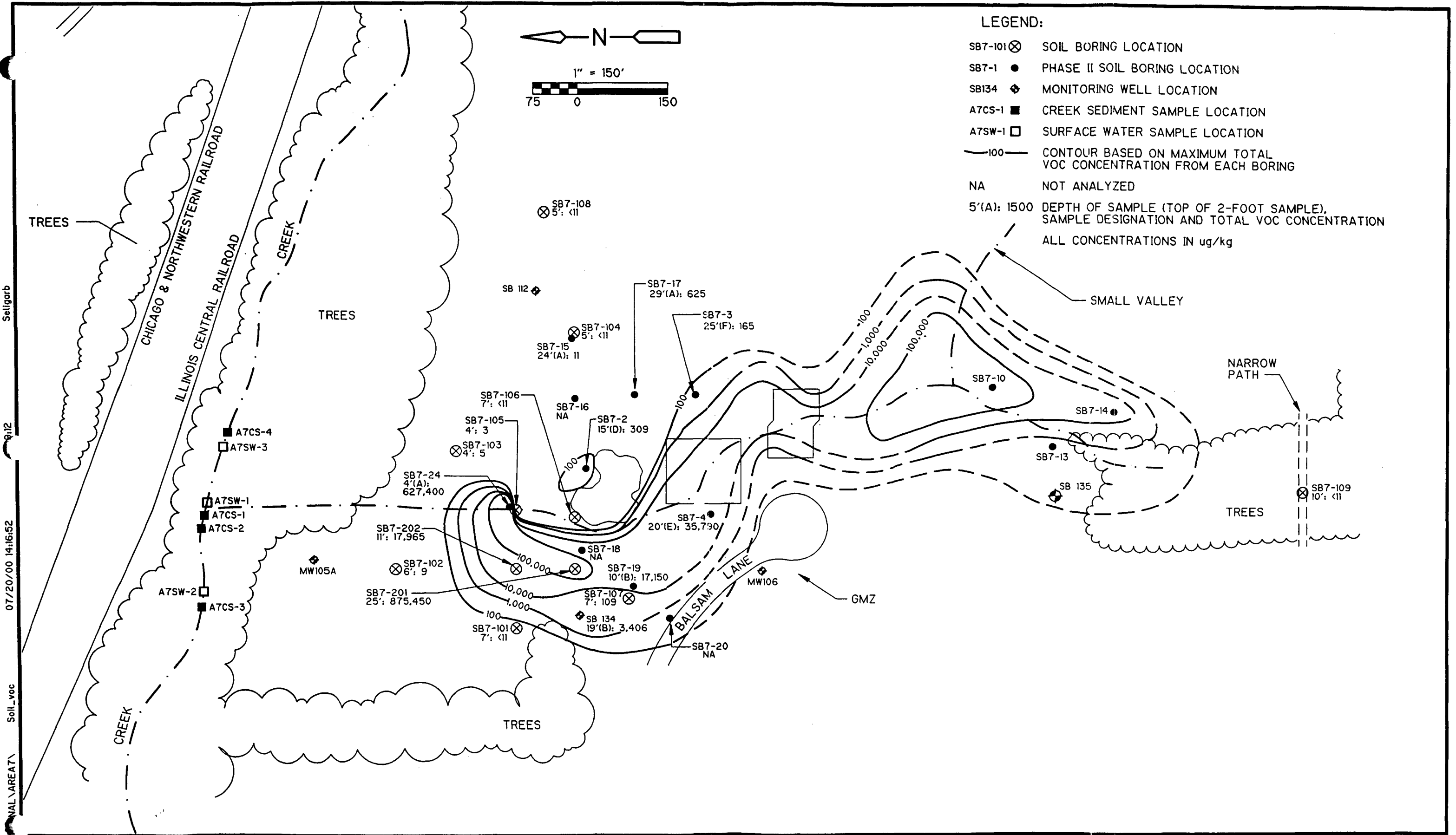
Parameter	Organic Surface Water Samples - Area 7	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/L)</u>		
Chloroethane	10 - 10	1 / 5 (20%)
1,1-Dichloroethene	1 - 1	1 / 5 (20%)
1,1-Dichloroethane	13 - 30	4 / 5 (80%)
1,2-Dichloroethene (total)	31 - 54	4 / 5 (80%)
1,1,1-Trichloroethane	7 - 36	4 / 5 (80%)
Trichloroethene	1 - 1	2 / 5 (40%)
<u>Semivolatile Organics (ug/L)</u>		
4-Nitrophenol	2 - 2	1 / 5 (20%)
Diethylphthalate	2 - 2	1 / 5 (20%)
Pyrene	2 - 2	1 / 5 (20%)
<u>Pesticides & PCBs (ug/L)</u>		
alpha-BHC	0.0012 - 0.0012	1 / 5 (20%)
gamma-BHC (Lindane)	0.001 - 0.001	1 / 5 (20%)
Dieldrin	0.00086 - 0.00086	1 / 5 (20%)
Endosulfan II	0.002 - 0.0037	2 / 5 (40%)
Endrin ketone	0.0023 - 0.0024	3 / 5 (60%)
Endrin aldehyde	0.0022 - 0.0026	2 / 5 (40%)

subsurface soil at the north end of Ekberg Park, a distance of about 600 feet (Figures 3-10 and 3-11). Moreover, Phase I and II groundwater samples collected at MW105A contained the same VOCs as the creek water samples (refer to Table 4-2 in CDM, 1992 for Phase I groundwater results, and Appendix H-9 in CDM, 1995 for the Phase II groundwater data). In both the surface water and groundwater samples, the breakdown products 1,2-DCE and 1,1-DCA were found at greater concentrations than the parent compounds TCE and TCA; PCE was typically at or below the detection limit and non-chlorinated VOCs such as toluene and xylene, which are present at elevated concentrations in soil, were not detected in either surface water or groundwater. Toluene and xylene tend to degrade more rapidly than chlorinated VOCs (see Section 4 of this report) and would not be expected in groundwater discharging to the creek.

Shallow groundwater appears to be discharging to the creek based on water table elevations determined in the nested wells MW105A and 105B during the Phase II investigation (refer to Table 3-3 in CDM, 1995).

Results of the SCOU investigation has confirmed the existence of highly contaminated soils in the northern part of Area 7. Figures 3-12 and 3-13 show the extent of soil contamination for total VOCs and xylene, respectively. The area of highest contamination occurs west and northwest of the playground in Ekberg Park, where total VOCs exceed 800,000 $\mu\text{g}/\text{kg}$ and xylene was detected at 190,000 $\mu\text{g}/\text{kg}$. The depth of highly contaminated soil varies from 4 feet (SB7-24) to over 25 feet (SB7-201). The pattern of soil contamination in the north end of Area 7 is consistent with the rest of the area in that the largest concentrations are located along the small drainage valleys that begin south of the basketball courts. It should be noted that aerial photographs of Area 7 indicate that prior to about 1988, the drainage valley west of the playground was located roughly 50 to 60 feet farther west than the present-day location shown on Figures 3-6 and 3-7. Figure 1-4 in this report shows the pre-1988 location of the valley, as well as the disturbed areas near the playground. Soil boring SB7-201 was drilled in the pre-1988 location of the valley and along with SB7-24 is located in the large, northernmost disturbed area shown on Figure 1-4.

The volume of contaminated subsurface soils in Area 7 was previously estimated in the Phase II investigation at 260,000 yd^3 (Section 4.5.1.3, CDM, 1995), not including the northern area of highly contaminated soils that was delineated in the present investigation. The volume of contaminated soil for the northern hot spot is estimated using the area of the disturbed area and the subsurface interval in borings SB7-201 and -202 that had field headspace concentrations greater than 15 ppm. Figure 1-4 shows the disturbed area near the playground as roughly elliptical in shape with axial dimensions of 208 feet (long axis) by 56 feet (short axis), corresponding to an area of approximately 9,150 square feet. Headspace readings for SB7-201 and -202 exceeded 15 ppm (refer to boring logs in Appendix C) over a depth interval greater than 18 feet and 10 feet, respectively (Figure 3-14). For the volume estimation, an average value of 15 feet was used, providing a total of 5,000 yd^3 for the northern hot spot in Area 7. The total estimated volume of highly contaminated soil is 265,000 yd^3 in Area 7.



SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
**AREA 7 TOTAL VOCs
IN SUBSURFACE SOILS**
Figure No. 3-12

The volume estimate for highly contaminated soils in Area 7 is only a rough, first-order approximation for two primary reasons: 1) the concentration of TCA and other VOCs in subsurface soils is highly variable over short distances (less than 20 feet as shown by the results for SB7-105 and SB7-24 provided on Figure 3-12), probably due to the natural variability in subsurface soils, which in turn influences contaminant abundance; and 2) the continuity of subsurface contamination between borings is known only with limited certainty -- significant variability is expected across distances of 70 to 125 feet, the typical distance between borings over much of Area 7. The reasons cited above are particularly significant, because different estimates of contaminant abundance in the high-contaminant zones have an overwhelming effect on total estimated contaminant volumes. As a result, the estimates of contaminated soil volume and, particularly, contaminant volume, are only first-order approximations.

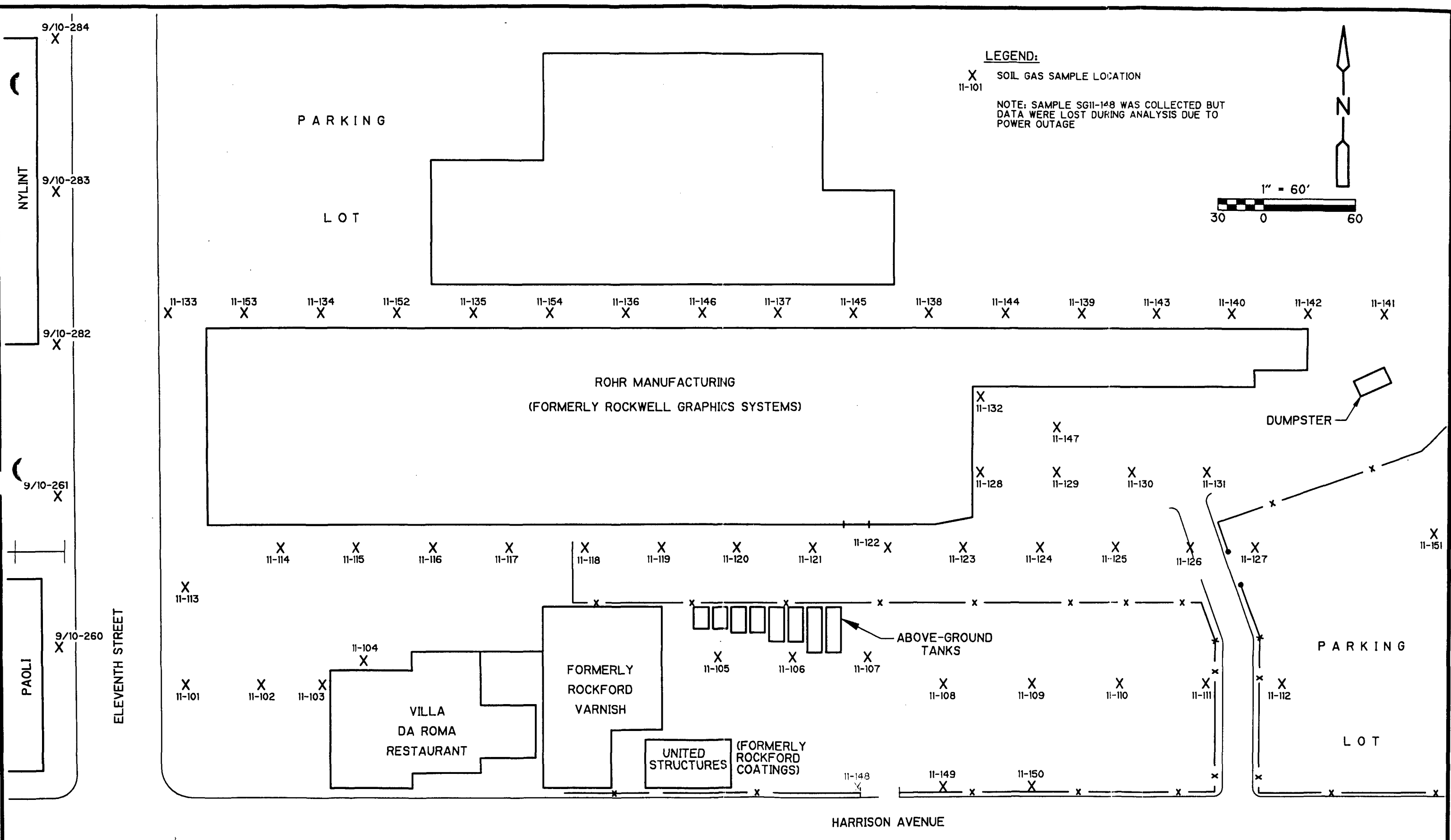
3.3 Area 11

3.3.1 Description

This section documents the investigation objectives, potential releases and migration pathways and results of field activities for Source Area 11 during CDM's SCOU investigation. The Area 11 investigation was conducted to build upon site information collected from previous investigations, to characterize the nature and extent of contamination (including non-aqueous phases), and to provide detailed information to support source remediation.

Area 11 is located on the corner of Harrison Avenue and 11th Street and includes the Rohr Manufacturing facility (formerly Rockwell Graphics Systems), former Rockford Varnish building, H & H Wood Products and Pallets, Villa di Roma Restaurant (building formerly part of Rockford Varnish), and adjacent parking lots (Figure 3-15). Industrial properties surround the entire area with some residential neighborhoods located farther south.

Several contaminant release and migration pathways exist in Area 11. One primary contaminant source is the eight above-ground storage tanks that previously contained volatile organic compounds (including chlorinated solvents) used in operations at the former Rockford Varnish facility. Potentially leaking tanks and above-ground product piping may have released VOCs into the vadose zone. A second contaminant source is a bunker, reportedly used by the Rockford Varnish Company, that previously seeped a tar-like substance. Historical reports of a Rockwell Graphics dumpster leaking cutting oils onto the underlying soils and an oily sheen observed in a pit north of the facility, indicate other surface spills have occurred. Potential releases of volatiles, solvents and oils have occurred due to past spillage, possible dumping, uncontained storage or poor housekeeping. Affected media by historical releases include surface and subsurface soils and groundwater.



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
 AREA 11 SOIL GAS SAMPLE LOCATIONS

Figure No. 3-15

Subsurface pathways exist that may serve as conduits for contaminant release and migration. Possible contaminants within the fill and surface soils may leach laterally and downward into the groundwater. Contaminants that reach groundwater may either exist in a non-aqueous phase (product) or a dissolved-phase depending upon the volume of product released and the physical and chemical properties of the contaminant. Dissolved-phase contaminant migration is dependent upon the gradient and direction of groundwater flow, aquifer media through which it is traveling, and the physical and chemical characteristics of the contaminant. Additionally, spills or leached contaminants may preferentially migrate along utilities in the sand or fill in utility trenches.

3.3.2 Results of the SCOU Investigation -- Area 11

Soil Gas

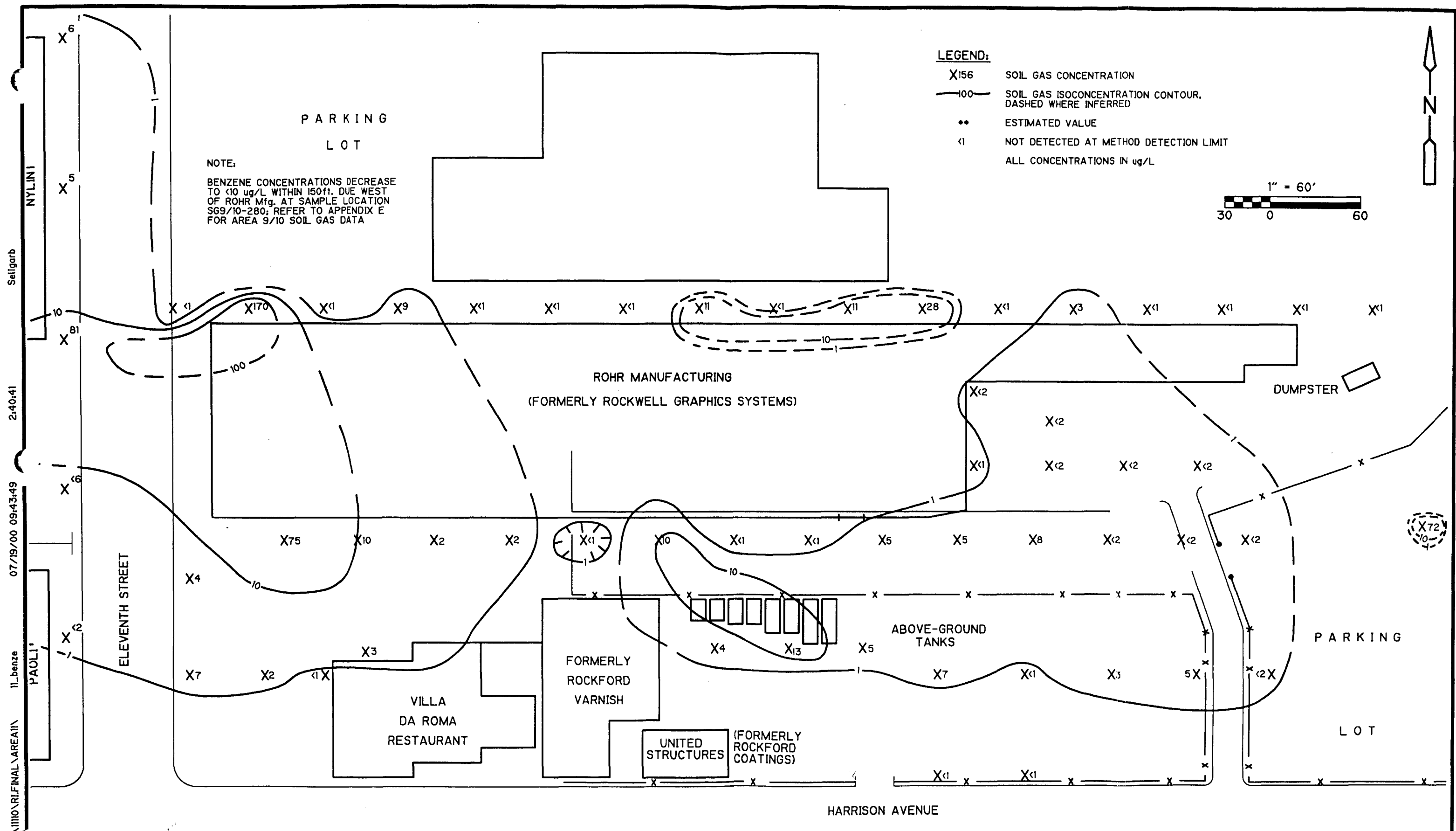
A soil gas survey was conducted to delineate the areal extent of VOC impact to the subsurface and to identify any "hot spots" indicative of potential pockets of product within the soil. Soil gas survey results were then used to locate Geoprobe soil samples and deep soil borings. A total of 54 soil gas samples were collected in Area 11. A more detailed discussion of soil gas sampling procedure and methodology is provided in Section 2.2 of this report.

Soil gas data are presented in Appendix C, and soil gas sampling locations are shown on Figure 3-15. Total BTEX and total VOC results are presented on Figures 3-16 and 3-17, respectively. Concentration plots showing the distribution of benzene, tetrachloroethene, trichloroethene, vinyl chloride and trichloroethane are presented on Figures 3-18, 3-19, 3-20, 3-21 and 3-22, respectively.

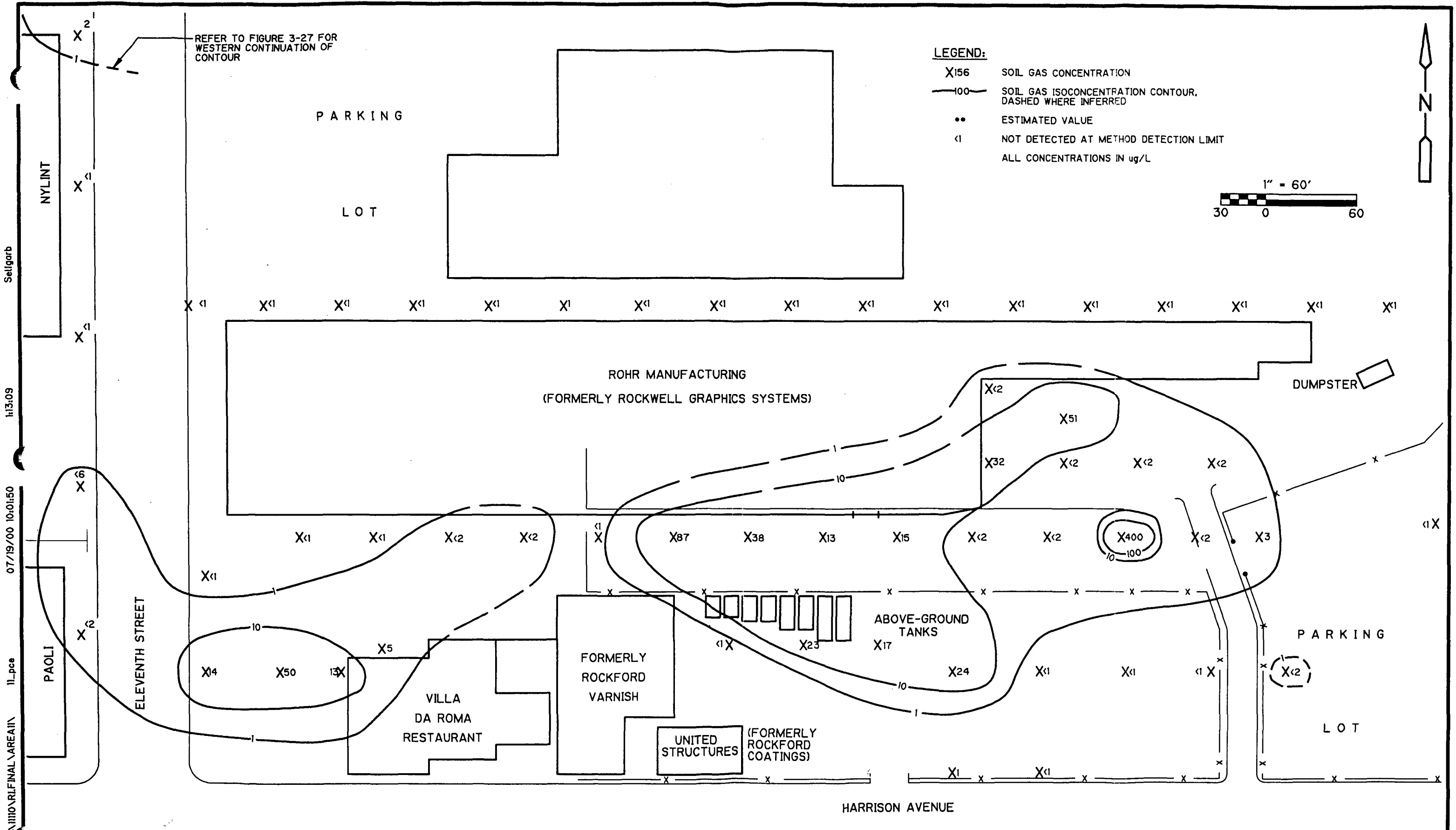
Elevated total BTEX concentrations were detected in soil gas along the western edge of Area 11 (north and south of Rohr Manufacturing), in the central area near the above-ground storage tanks (ASTs), and east of the ASTs (Figure 3-16). The highest total BTEX values ($>1,000 \mu\text{g/L}$) occurred north and south of Rohr Manufacturing along the western margin of Area 11. Elevated VOC concentrations ($>100 \mu\text{g/L}$) were detected in soil gas from the central area near the ASTs and east of Rohr Manufacturing (Figure 3-17). PCE (Figure 3-19) and TCA (Figure 3-22) were the most prevalent VOCs detected in the central and eastern areas.

Subsurface Soil Sample Results

Seventeen soil borings were advanced in areas exhibiting both elevated and low soil gas VOC results to delineate the vertical extent of subsurface soil contamination in Area 11. A more detailed description of the subsurface soil sample procedure and methodology is located in Section 2.2 of this report. A list of organic compounds detected in the subsurface soil samples in Area 11 is presented in Table 3-9. Inorganic results from SB11-204 are presented in Table 3-10. Soil boring sample locations are

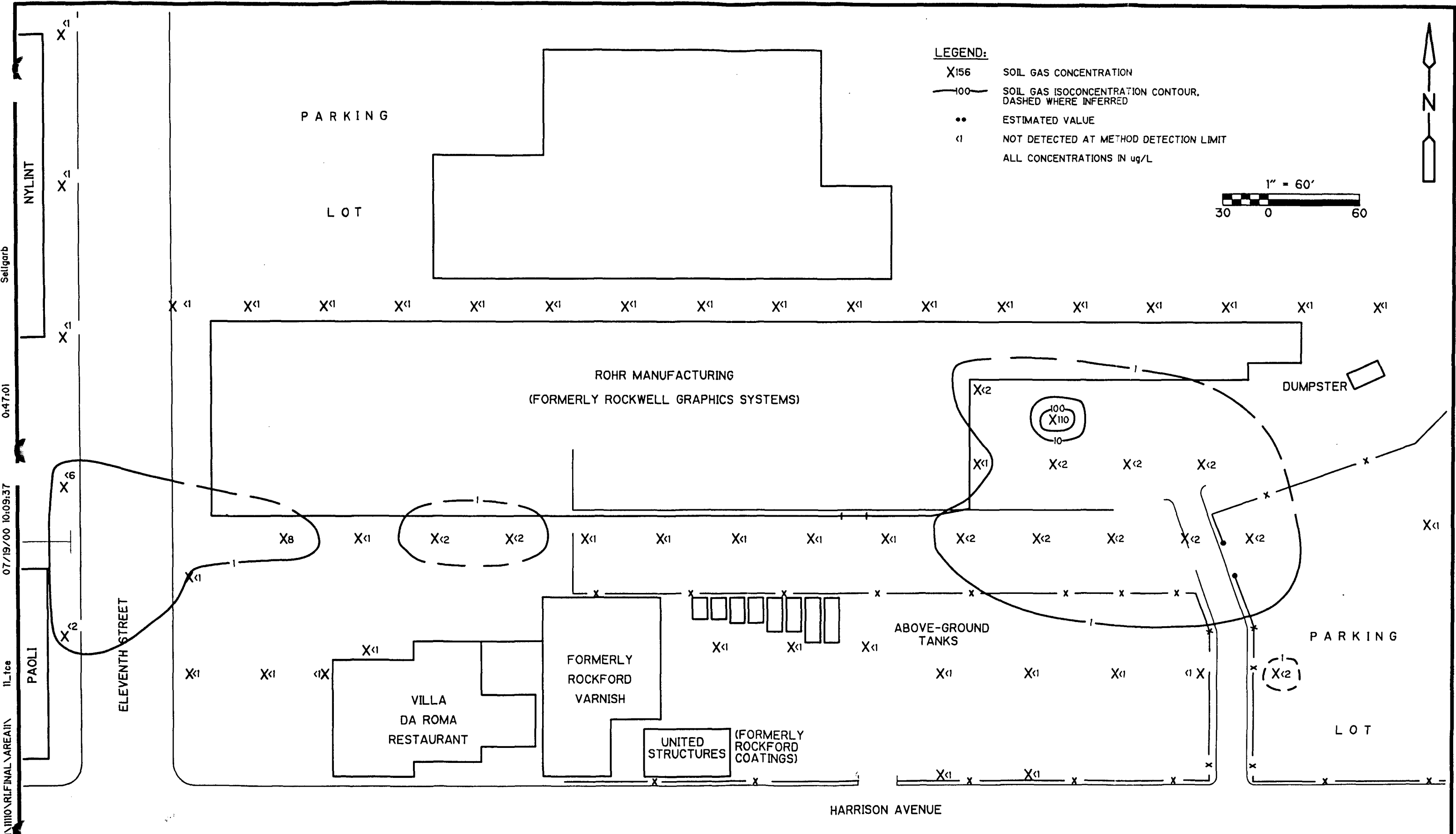


SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
 AREA 11 SOIL GAS RESULTS
 FOR BENZENE



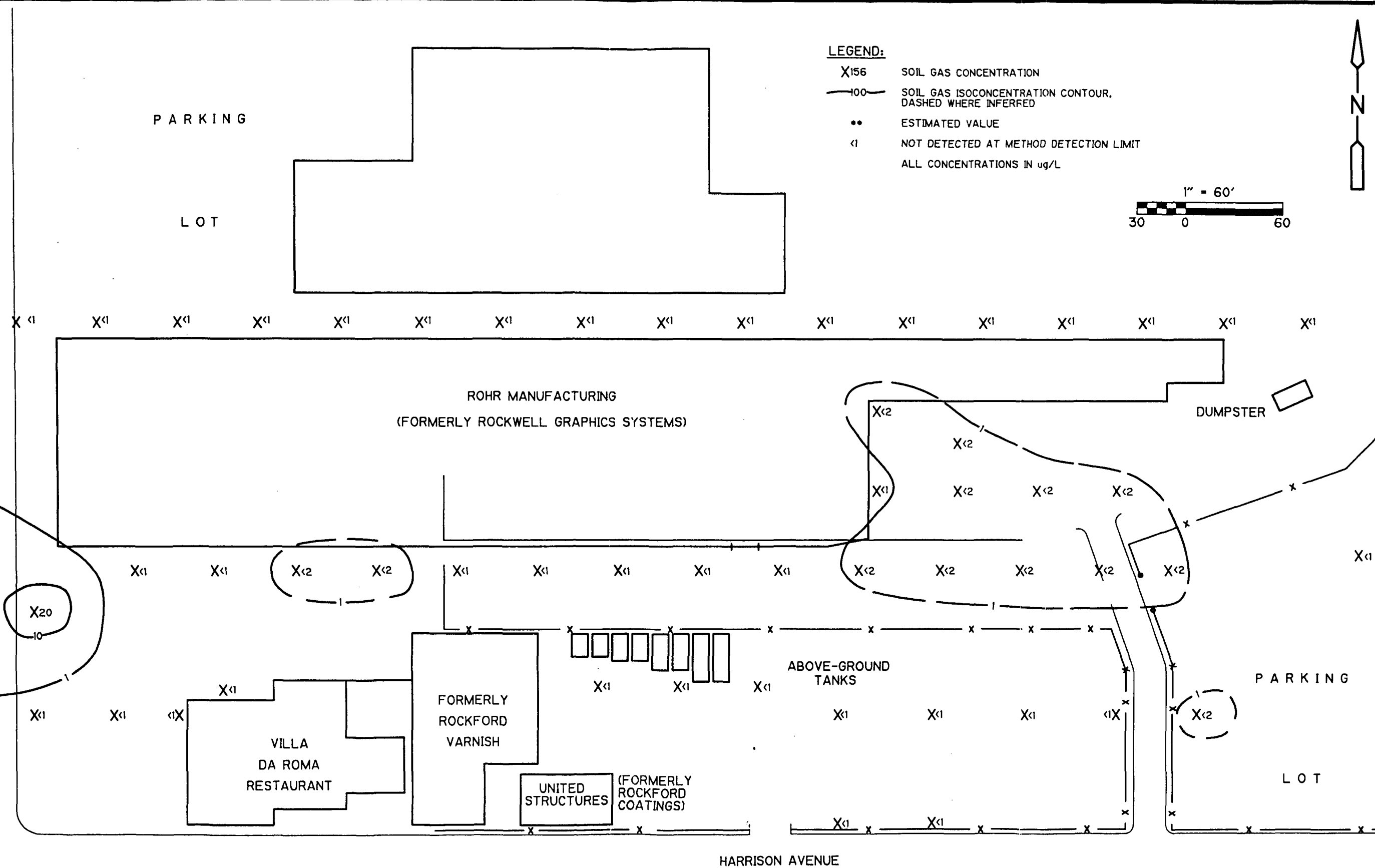
SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
 AREA 11 SOIL GAS RESULTS
 FOR PCE

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SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

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SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
AREA 11 SOIL GAS RESULTS
FOR VINYL CHLORIDE

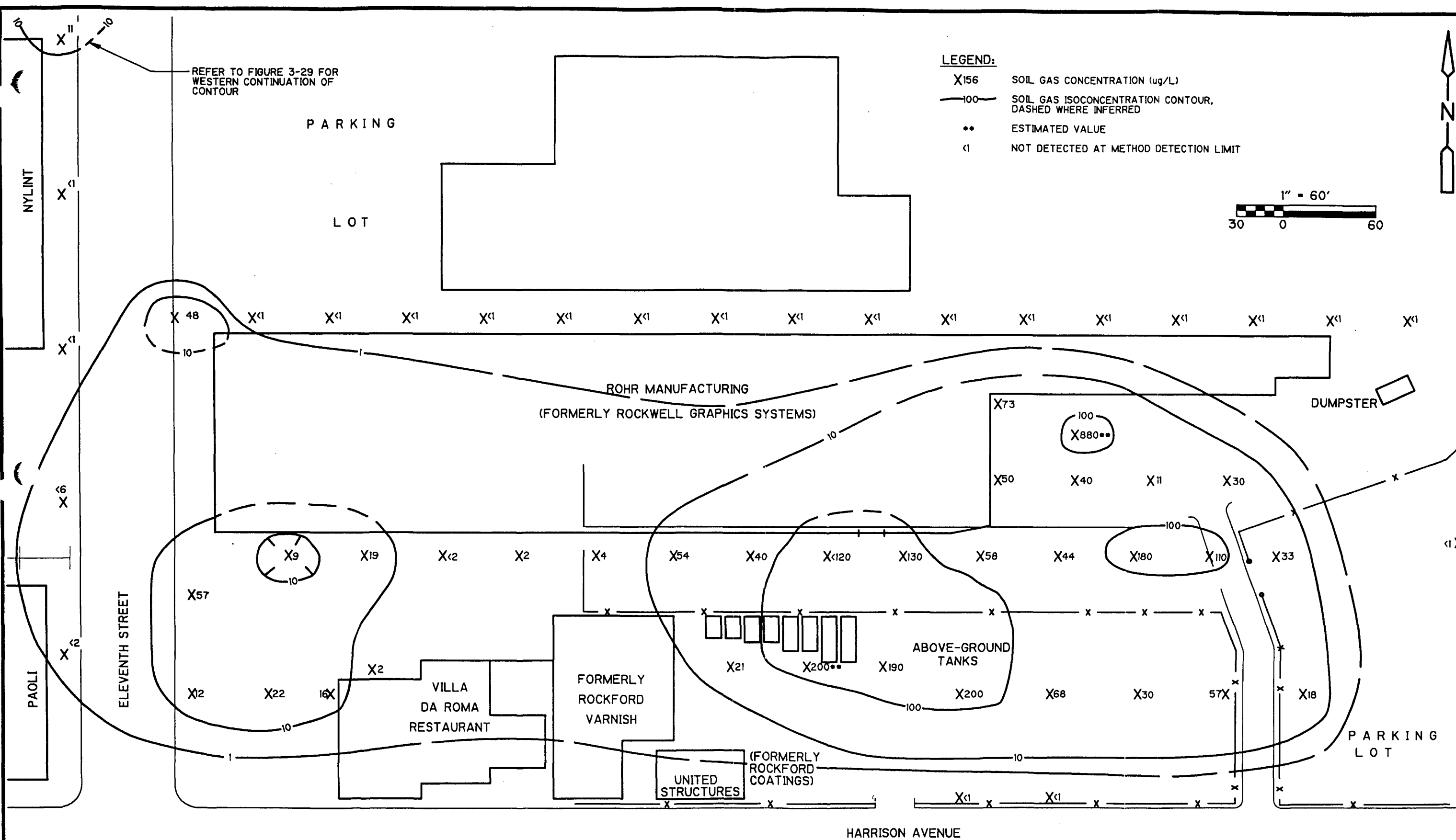
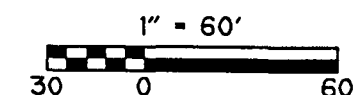
REFER TO FIGURE 3-29 FOR
WESTERN CONTINUATION OF
CONTOUR

P A R K I N G

L O T

LEGEND:

- X156 SOIL GAS CONCENTRATION (ug/L)
- 100 SOIL GAS ISOCONCENTRATION CONTOUR,
DASHED WHERE INFERRED
- ESTIMATED VALUE
- <1 NOT DETECTED AT METHOD DETECTION LIMIT



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT

AREA 11 SOIL GAS RESULTS
FOR TCA

Figure No. 3-22

CDM

environmental engineers, scientists,
planners, & management consultants

Table 3-9

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Sub-surface Soil Boring Sample Analysis - Area 11

Parameter	Organic Soil Boring Samples - Area 11	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
Acetone	2 - 5100	8 / 31 (26%)
2-Butanone	4 - 4	1 / 31 (3%)
1,1,1-Trichloroethane	4 - 4	1 / 31 (3%)
Tetrachloroethene	1 - 2	2 / 31 (6%)
Toluene	180000 - 180000	2 / 31 (6%)
Ethylbenzene	20000 - 120000	2 / 31 (6%)
Xylene	1 - 650000	4 / 31 (13%)

Table 3-10

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Inorganic Sub-surface Soil Boring Sample Analysis - Area 11

Parameter	Inorganic Soil Boring Samples - Area 11	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	1300 - 1300	1 / 1 (100%)
Antimony	7.6 - 7.6	1 / 1 (100%)
Arsenic	0.63 - 0.63	1 / 1 (100%)
Barium	5.3 - 5.3	1 / 1 (100%)
Calcium	43400 - 43400	1 / 1 (100%)
Chromium	4.4 - 4.4	1 / 1 (100%)
Cobalt	1.7 - 1.7	1 / 1 (100%)
Copper	3.2 - 3.2	1 / 1 (100%)
Iron	4050 - 4050	1 / 1 (100%)
Lead	1.6 - 1.6	1 / 1 (100%)
Magnesium	19500 - 19500	1 / 1 (100%)
Manganese	107 - 107	1 / 1 (100%)
Nickel	4.5 - 4.5	1 / 1 (100%)
Potassium	165 - 165	1 / 1 (100%)
Sodium	104 - 104	1 / 1 (100%)
Thallium	0.13 - 0.13	1 / 1 (100%)
Vanadium	6.4 - 6.4	1 / 1 (100%)
Zinc	8.9 - 8.9	1 / 1 (100%)
Cyanide	0.31 - 0.31	1 / 1 (100%)

shown on Figure 3-23. Table 3-10 shows the frequency of detection and range of concentrations for inorganic parameters detected in the subsurface soil boring sample analyses. Area 11 subsurface soil sampling VOC results are presented on Figure 3-24.

Surface Soil Samples

Seven surface soil samples were collected from locations in Area 11 where soil gas results indicated elevated VOC concentrations. Section 2.2 provides a description of surface soil sample collection procedures. Surface soil sample locations are depicted on Figure 3-23. The frequency of detection and range of concentrations for parameters detected in surface soil samples are presented in Tables 3-11 and 3-12.

3.3.3 Discussion -- Area 11

Past surface spills have been the primary source of releases to Area 11 surface and subsurface soils. Soil gas, subsurface soil and groundwater analytical results provide a means to evaluate the areal and vertical distribution of contaminants. Two distinct areas of subsurface contamination were defined using Phase II (CDM 1995) and SCOU results. The following discussion examines the nature and extent of contamination of these two zones.

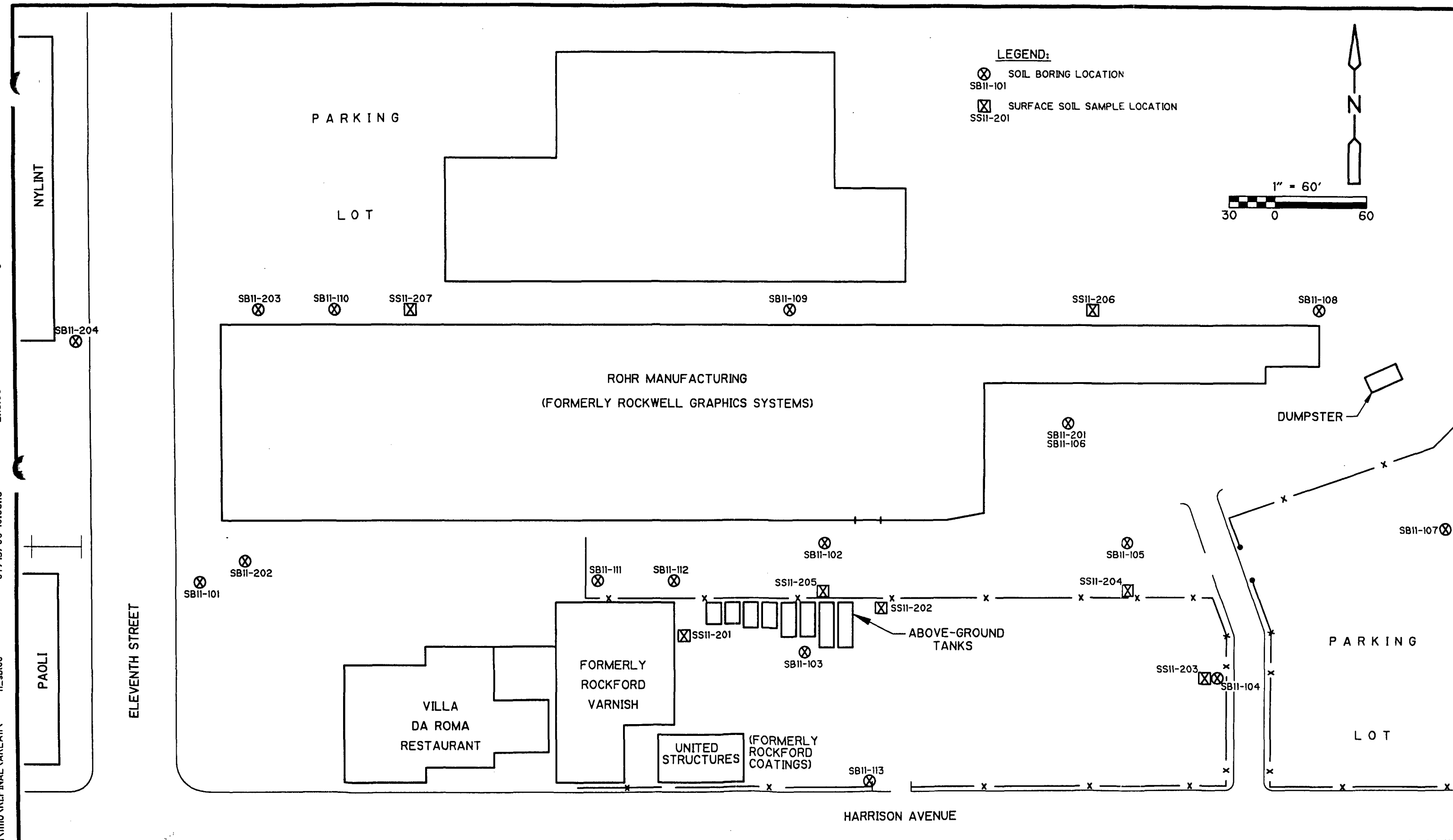
Rohr Manufacturing

The western margin of Area 11, in this discussion, includes the area north and south of Rohr Manufacturing, as far east as the former Rockford Varnish building and the west side of 11th Street (including SB11-204). Soil gas total BTEX isoconcentration mapping (Figure 3-16) yielded elevated concentrations ($>1,000 \mu\text{g/L}$) along the western border of Area 11. Subsequent subsurface soil samples collected at these soil gas "hot spots" showed elevated concentrations of toluene, ethylbenzene, xylene and acetone. Subsurface soils collected at SB11-203 (39-41 foot sample depth), north of Rohr Manufacturing (Figure 3-24), contained toluene ($180,000 \mu\text{g/kg}$), ethylbenzene ($20,000 \mu\text{g/kg}$), xylenes ($110,000 \mu\text{g/kg}$) and acetone ($5,100 \mu\text{g/kg}$) at elevated levels. To quantify these high concentrations, the detection limit for other compounds (e.g., TCA and PCE) was raised to $13,000 \mu\text{g/kg}$. Thus, chlorinated solvents may be present at concentrations below the detection limit of $13,000 \mu\text{g/kg}$.

LNAPLs (Non-Aqueous Phase Liquids) were detected during field screening of SB11-203 soil samples from 39 to 43 feet below ground surface. LNAPL detection was confirmed by the Sudan IV test and/or visual observation (see Section 2.4.1 for more detail). The NAPL was determined to be LNAPL because it was observed near the top of the water table and the NAPL was not detected at greater depth. If the product was DNAPL, the DNAPL would migrate downward through the soil until contacting an impermeable layer and follow topographic slope. Residual DNAPL was not detected at depth and therefore the NAPL was determined to be LNAPL.

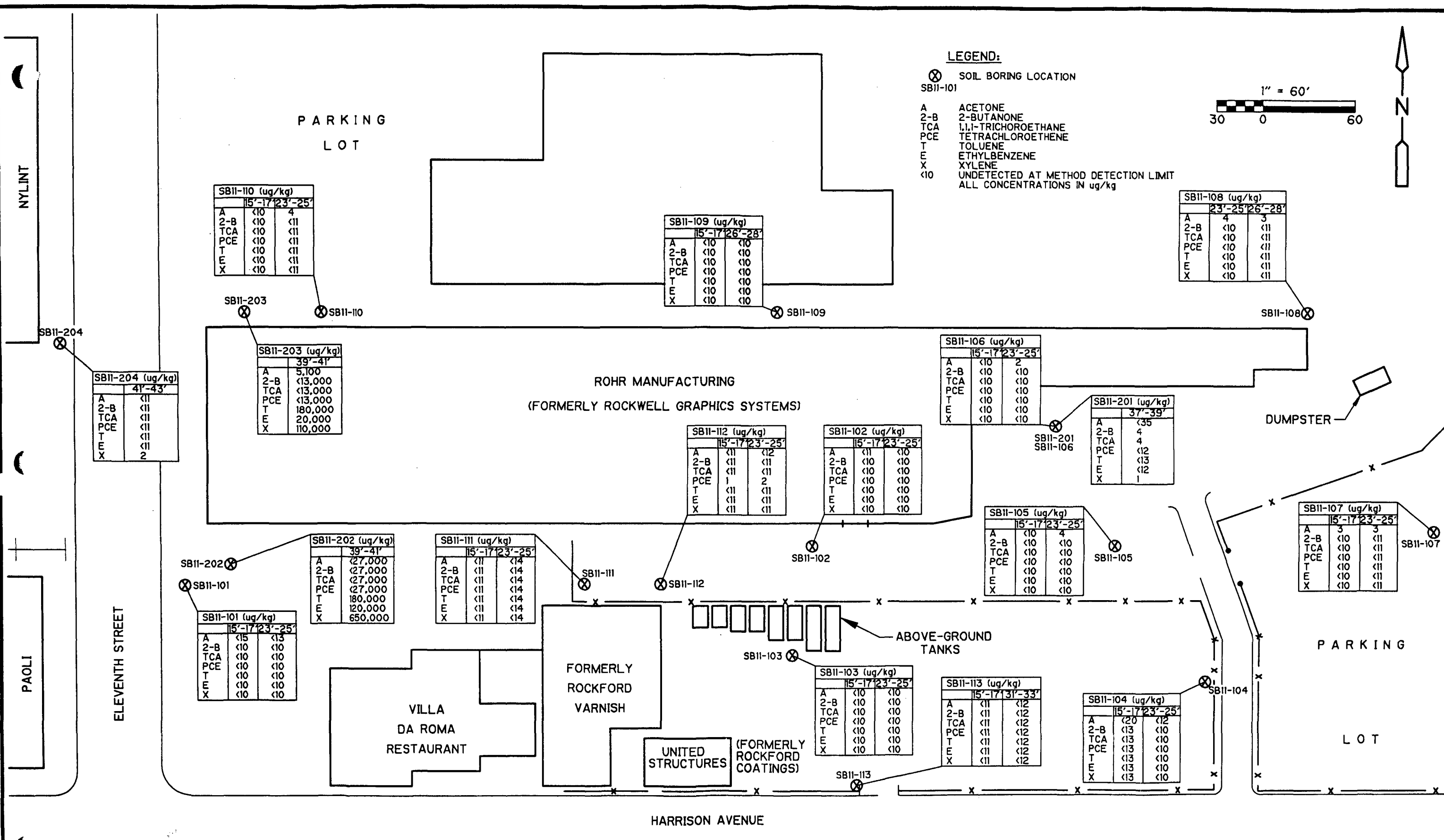
Field headspace measurements from 33 to 45 feet bgs were elevated (810 to $>1,000$ ppm). Because the SB11-110 soil sample (23-25 feet bgs), located 50 feet east of SB11-

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SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
AREA 11 SOIL BORING AND SURFACE SOIL
SAMPLE LOCATIONS

Figure No. 3-23



SOUTHEAST ROCKFORD SOURCE CONTROL OPERABLE UNIT
AREA 11 SUBSURFACE SOIL RESULTS
FOR VOCs

Table 3-11

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Surface Soil Analysis - Area 11

Parameter	Organic Surface Soils - Area 11	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
No Hits		
<u>Semivolatile Organics (ug/Kg)</u>		
Naphthalene	42 - 15000	2 / 7 (29%)
2-Methylnaphthalene	45 - 45	1 / 7 (14%)
Acenaphthene	70 - 39000	2 / 7 (29%)
Dibenzofuran	57 - 33000	2 / 7 (29%)
Fluorene	130 - 47000	2 / 7 (29%)
Phenanthrene	54 - 370000	7 / 7 (100%)
Anthracene	160 - 93000	2 / 7 (29%)
Carbazole	65 - 67000	2 / 7 (29%)
Di-n-Butylphthalate	94 - 5200	5 / 7 (71%)
Fluoranthene	110 - 440000	7 / 7 (100%)
Pyrene	57 - 430000	4 / 7 (57%)
Butylbenzylphthalate	44 - 44	1 / 7 (14%)
Benzo(a)anthracene	69 - 200000	7 / 7 (100%)
Chrysene	52 - 240000	7 / 7 (100%)
bis(2-Ethylhexyl)Phthalate	880 - 40000	7 / 7 (100%)
Di-n-Octyl Phthalate	66 - 100	2 / 7 (29%)
Benzo (b) Fluoranthene	86 - 220000	7 / 7 (100%)
Benzo (k) Fluoranthene	46 - 130000	7 / 7 (100%)
Benzo (a) Pyrene	96 - 150000	3 / 7 (43%)
Ideno (1,2,3-cd) Pyrene	63 - 120000	3 / 7 (43%)
Dibenzo (a,h) Anthracene	70 - 70	1 / 7 (14%)
Benzo (g,h,i) Perylene	2000 - 120000	2 / 7 (29%)

Table 3-11

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Surface Soil Analysis - Area 11

Parameter	Organic Surface Soils - Area 11	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Pesticides & PCBs (ug/Kg)</u>		
delta-BHC	0.24 - 0.38	2 / 7 (29%)
Heptachlor	13 - 13	1 / 7 (14%)
Aldrin	0.69 - 2.3	2 / 7 (29%)
Heptachlor epoxide	0.54 - 24	2 / 7 (29%)
Endosulfan I	0.64 - 0.64	1 / 7 (14%)
Dieldrin	0.11 - 10	6 / 7 (86%)
4,4'-DDE	0.79 - 3.5	2 / 7 (29%)
Endrin	0.68 - 1.2	2 / 7 (29%)
Endosulfan II	0.36 - 3.2	2 / 7 (29%)
4,4'-DDD	0.34 - 12	3 / 7 (43%)
4,4'-DDT	0.94 - 0.94	1 / 7 (14%)
Methoxychlor	4.6 - 30	5 / 7 (71%)
Endrin ketone	1.1 - 11	2 / 7 (29%)
Endrin aldehyde	0.47 - 9.7	3 / 7 (43%)
alpha-Chlordane	0.35 - 120	6 / 7 (86%)
gamma-Chlordane	3 - 180	2 / 7 (29%)
Aroclor-1254	31 - 530	4 / 7 (57%)
Aroclor-1260	350 - 450	2 / 7 (29%)

Table 3-12

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Inorganic Surface Soil Sample Analysis - Area 11

Parameter	Inorganic Surface Soils - Area 11	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	413 - 5690	7 / 7 (100%)
Antimony	0.52 - 0.55	2 / 7 (29%)
Arsenic	1 - 6.5	7 / 7 (100%)
Barium	6.5 - 131	7 / 7 (100%)
Beryllium	0.25 - 0.88	4 / 7 (57%)
Cadmium	0.26 - 4.3	7 / 7 (100%)
Calcium	5670 - 184000	7 / 7 (100%)
Chromium	4.3 - 22.7	7 / 7 (100%)
Cobalt	0.8 - 7.6	7 / 7 (100%)
Copper	4.1 - 90.9	7 / 7 (100%)
Iron	3500 - 21500	7 / 7 (100%)
Lead	15.5 - 458	7 / 7 (100%)
Magnesium	3200 - 119000	7 / 7 (100%)
Manganese	198 - 377	7 / 7 (100%)
Mercury	0.06 - 0.08	2 / 7 (29%)
Nickel	2.5 - 18.4	7 / 7 (100%)
Potassium	163 - 641	7 / 7 (100%)
Selenium	0.76 - 2	3 / 7 (43%)
Sodium	74.8 - 162	7 / 7 (100%)
Thallium	0.89 - 1.3	3 / 7 (43%)
Vanadium	2.5 - 24.1	7 / 7 (100%)
Zinc	32.5 - 263	7 / 7 (100%)
Cyanide	0.12 - 0.38	7 / 7 (100%)

203, yielded only one low level detection of acetone ($4 \mu\text{g/kg}$), the vertical extent of contamination, north of Rohr Manufacturing, is probably limited to the upper part (33 to 45 feet bgs) of the saturated zone. No previous soil borings were advanced in this area for comparison.

SB11-202, located near the western margin of Area 11 and directly south of Rohr Manufacturing (Figure 3-24), also exhibited elevated levels of toluene ($180,000 \mu\text{g/kg}$), ethylbenzene ($120,000 \mu\text{g/kg}$) and xylenes ($650,000 \mu\text{g/kg}$) (39-41 foot sample depth). Due to these high concentrations, the detection limits for acetone, 2-butanone, TCA and PCE were raised to $27,000 \mu\text{g/kg}$ and these compounds were not detected above the laboratory detection limits. However, low soil gas total VOC results in this area (Figure 3-17) indicate that the chlorinated solvents, if present, probably occur at low levels.

NAPLs were detected in SB11-202 soil samples (based on Sudan IV testing and visual observation) from 39 to 45 feet bgs. Elevated field headspace measurements (580 to $>1,000$ ppm) were also observed from 31 to 55 feet bgs. No VOCs were detected in the nearby shallow soil sample, SB11-101 (15-17 and 23-25 feet bgs) (Figure 3-24). Therefore, the vertical extent of contamination in this area is also limited to the upper part (31 to 55 feet bgs) of the saturated zone. Phase II VOC results from nearby soil borings MW128 and SB11-10 (CDM 1995; Figure 4-24) also yielded elevated toluene ($470,000$ and $1,400,000 \mu\text{g/kg}$, respectively), ethylbenzene ($240,000$ and $590,000 \mu\text{g/kg}$, respectively) and xylenes ($980,000$ and $2,300,000 \mu\text{g/kg}$, respectively) at similar depths (40 and 35 feet bgs, respectively).

Although field headspace measurements from SB11-204 soils, located west of 11th Street, were elevated (400 to $>1,000$ ppm), NAPL was not found and xylene ($2 \mu\text{g/kg}$) was the only VOC detected in soil. The elevated headspace measurements may be the result of dissolved-phase contamination migrating across 11th Street in the direction of groundwater flow.

One surface soil sample, SS11-207, was collected from a grassy area 50 feet east of SB11-110 (Figure 3-15). Although no VOCs were detected, numerous SVOCs were detected at elevated concentrations (Table 3-11) ranging from $15,000 \mu\text{g/kg}$ (naphthalene) to $440,000 \mu\text{g/kg}$ (fluoranthene). A surface spill has occurred at this location based on these SVOC results. Several pesticides/insecticides, including heptachlor ($13 \mu\text{g/kg}$), heptachlor epoxide ($24 \mu\text{g/kg}$), endrin ketone ($11 \mu\text{g/kg}$), endrin aldehyde ($9.7 \mu\text{g/kg}$), alpha-Chlordane ($120 \mu\text{g/kg}$) and gamma-Chlordane ($180 \mu\text{g/kg}$) were detected. The PCB Aroclor-1260 was also detected at $350 \mu\text{g/kg}$.

Above-Ground Storage Tank Area

Soil gas total BTEX and VOC isoconcentration maps show several areas with concentrations exceeding $100 \mu\text{g/L}$ near the above-ground storage tanks (Figure 3-16 and 3-17). However, PCE was only detected from one soil boring (SB11-112) at $1 \mu\text{g/kg}$ (15-17 feet bgs) and $2 \mu\text{g/kg}$ (23-25 feet bgs) in the center of Area 11. Phase II

subsurface soil samples, SB11-4 and SB11-8, collected between Rohr Manufacturing and the former Rockford Varnish facility near the above-ground storage tanks (CDM 1995; Figure 4-24), revealed elevated levels of toluene (290,000 and 43,000 µg/kg, respectively) and xylenes (17,000 and 2,000 µg/kg, respectively) at 35 feet below ground surface. PCE was also detected in SB11-3 (CDM 1995; Figure 4-24) at 46 µg/kg (20 feet bgs). Thus, the VOC contamination in the central section of Area 11 is limited to the area around and west of the above-ground storage tanks, and begins at approximately 35 feet below ground surface.

Three surface soil samples, SS11-201, SS11-202 and SS11-205 were collected in the central section of Area 11 (Figure 3-15). SVOCs, detected in all three samples at low concentrations, included phenanthrene (54-88 µg/kg), fluoranthene (110-160 µg/kg), benzo(a)anthracene (69-85 µg/kg), chrysene (52-79 µg/kg), benzo(b)fluoranthene (86-99 µg/kg), benzo(k)fluoranthene (46-100 µg/kg) and bis(2-ethylhexyl)phthalate (880-24,000 µg/kg) (Table 3-11). Several pesticides were detected at low concentrations and Aroclor-1254 was detected in SS11-201 (57 µg/kg) and SS11-202 (31 µg/kg). Although SVOCs, pesticides and one PCB were detected in these soils, SVOC contaminant concentrations were three to four orders of magnitude lower than in SS11-207 along the eastern margin of Area 11. Also, no VOCs were detected in the surface soils in the central area.

Although elevated soil gas concentrations of PCE (Figure 3-19) and TCA (Figure 3-22) were observed at SG11-125 and SG11-147, respectively (Figure 3-15), only trace amounts of VOCs were detected in subsurface soil sample SB11-201 and SB11-106 (same location as SG11-147). If a spill had occurred at this location, the subsurface soils would contain higher levels of VOCs than detected. These subsurface soil results indicate that there is not a source at this location. Rather, the elevated soil gas concentrations probably result from the lateral migration of soil gas under the pavement from an adjacent source area or through volatilization off the water table and upward migration through the vadose zone.

Small amounts of acetone were also detected at SB11-106 (2 µg/kg), SB11-105 (4 µg/kg), SB11-107 (3 µg/kg) and SB11-108 (3 µg/kg) (Figure 3-24). Although total BTEX soil gas results were slightly elevated (>100 µg/L) in two areas along the eastern margin (SG11-151 and SG11-110), no BTEX was detected in the soil samples from these locations. As previously explained, the elevated soil gas results are probably the result of lateral migration from other source areas and/or through the vertical migration of soil gas off of the water table.

Three surface soil samples, SS11-203, SS11-204 and SS11-206, were collected along the eastern margin of Area 11 (Figure 3-15). SS11-206, located north of Rohr Manufacturing, exhibited the highest concentrations of 12 SVOCs in the eastern area surface soil samples with results ranging from 2,000 µg/kg [benzo(ghi)perylene] to 37,000 µg/kg [bis(2-ethylhexyl)phthalate] (Table 3-11). Several pesticides were detected at low concentrations in all three samples, and Aroclor-1254 was detected in SS11-203 (21 µg/kg) and SS11-204 (530 µg/kg). Aroclor-1260 was detected in SS11-

206 at 450 µg/kg. Surface soil SVOC results indicate that surface spills may have occurred at SS11-206 and SS11-204.

Extent of Contamination

Area 11 contamination consists primarily of aromatics (xylene, toluene and ethylbenzene), though elevated concentrations of several chlorinated VOCs are also present in the groundwater and soils. Historical Area 11 groundwater sampling results show the presence of VOCs, including chlorinated solvents and ETX, in the groundwater. Previous groundwater VOC results show elevated concentrations of toluene in the west (MW128 at 9,200 µg/L) and central (IW-10 at 310,000 µg/L; IW-11 at 140,000 µg/L) areas. Ethylbenzene (1,800 µg/L at IW-11 and 3,900 µg/L at MW128) and xylenes (8,000 µg/L at IW-11 and 16,000 µg/L at MW128) were also previously detected in Area 11 groundwater. Chlorinated solvents including TCE (IW-11 at 170 µg/L; MW129 at 1 µg/L; and MW2 at 302 µg/L), PCE (MW129 at 1 µg/L) and TCA (MW129 at 10 µg/L and MW-2 at 302 µg/L) have also been previously detected. The historical groundwater VOC results corroborate the subsurface soil analytical results showing elevated ETX levels in the central and western areas.

A rough estimate of the volume of contaminated soil can be made based on recent and historical quantitative subsurface soil VOC results, NAPL field testing of soils, soil gas survey results, organic vapor field screening and visual observations of subsurface soil samples. Two areas of ETX contamination exist in Area 11 and they include: the western margin south and north of Rohr Manufacturing and west of the former Rockford Varnish facility and the central area along the northern border of Rockford Varnish including the area north of the above-ground storage tank area.

Subsurface soil quantitative results from SB11-202 and SB11-203 and the Geoprobe soil borings, Phase II ETX results and corresponding sample depths, NAPL field testing, soil gas results, and organic vapor readings (ranging from 500 to 1,000 ppm) were used to determine contaminant thickness. The thickness of ETX contamination in the west ranges from 12 feet (SB11-203) to 24 feet (SB11-202). Fifteen feet was chosen as a conservative estimate of the western ETX contaminant thickness. The estimated western contaminated area (north and south of Rohr) is around 17,000 ft² (calculated using a rectangle extending from the western edge of Rohr to the western edge of Rockford Varnish [234 feet x 60 feet] and a rectangle 60 feet x 50 feet north of Rohr) (Figure 3-25). Thus, the average thickness (15 feet) multiplied by the area (17,000 ft²) yields approximately 256,000 ft³ of contaminated area (not including the soil underneath the Rohr building). If the area underneath Rohr (7,900 ft²) (Figure 3-25) is included in the calculation, the contaminated area in the west totals 375,000 ft³.

The ETX contaminant thickness in the center of Area 11 extends from around 35 feet bgs to an unknown depth. Since the total thickness of contamination is not completely defined, a conservative estimate of 10 feet was used. The estimated area of

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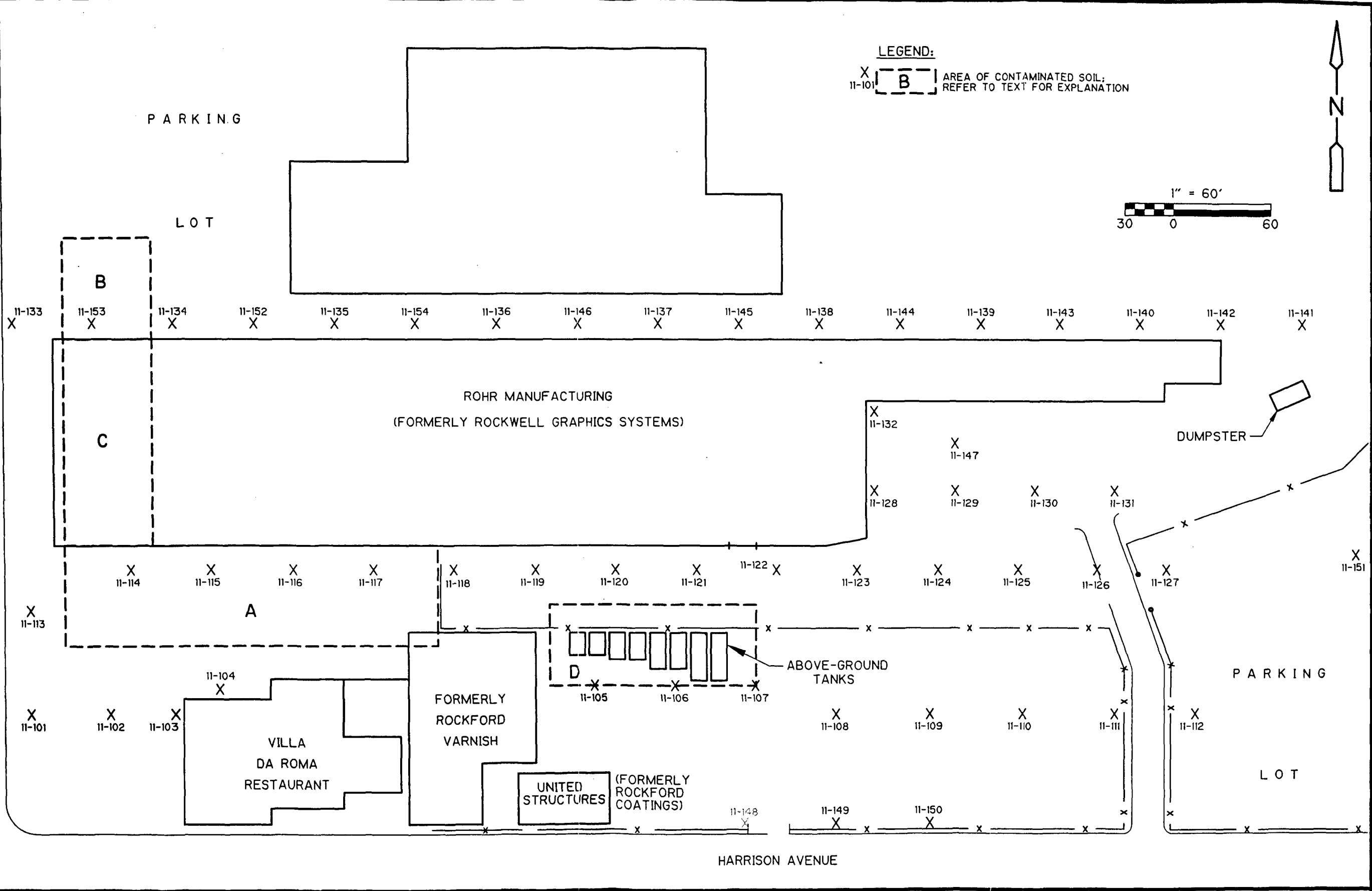
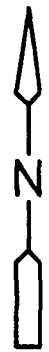
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HARRISON AVENUE

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REFER TO TEXT FOR EXPLANATION

1" = 60'
30 0 60



contamination is 6,000 ft² (126 feet x 48 feet rectangle around the ASTs). Thus, the total volume of ETX contamination in the AST area is approximately 60,500 ft³.

3.4 Area 9/10

3.4.1 Description

Source Area 9/10 is primarily an industrial area bounded by Harrison Avenue to the south, 11th Street to the east, and 23rd Avenue to the north; the west boundary is located approximately 1,700 feet west of 9th Street (Figure 3-26). Area 9/10 is the combination of two formerly separate potential source areas that were identified for the Phase II RI (CDM 1995): Area 9 west of 9th Street and Area 10 east of 9th Street. The term Area 9/10 was retained during the SCOU investigation for the area shown on Figure 3-26 because both sides of 9th Street were investigated. Note that Source Area 11 borders Area 9/10 to the east.

Industrial facilities are located throughout Area 9/10, particularly along Harrison Avenue and along 9th and 11th Streets. The northern half of Area 9/10, between 9th and 11th Streets, is occupied mainly by Sundstrand Corporation's Plant #1 and former Mid-States Industrial Company (also known as Rockford Power Machinery), which was located in the northeast corner (intersection of 11th Street and 23rd Avenue). Other facilities referred to in the sections below include Nylint, Rockford Products, Paoli Manufacturing Company (Paoli), Rohrbacher Manufacturing, and J. L. Clark, Incorporated (Figure 3-26). Area 9/10 is largely covered by concrete or asphalt pavement, except for the area surrounding the Nylint facility and along the railroad tracks located between Rockford Products and Rohrbacher Manufacturing. It should be noted that Nylint only occupies the facility and does not own the property. Private residences are located north of 23rd Avenue.

The stratigraphy of Area 9/10 consists of unconsolidated sand and gravel to a depth of at least 101 feet, as determined by the maximum depth of boreholes drilled for the SCOU investigation (SB9/10-201; boring logs for Area 9/10 are given in Appendix E). No clay or silt units were encountered in the SCOU borings to a depth of 101' (SB-201), with the exception of some fill material within 8 feet of ground surface. The boring logs (Illinois State Geological Survey well records) for two boreholes located at 2501 9th Street (northwest corner of 9th Street and Harrison Avenue) indicates that bedrock is roughly 235 to 240 feet deep in Area 9/10. In addition, one of the ISGS drilling logs identified a ten-foot thick till unit from 120 to 130 feet deep at 2501 9th Street; the remainder of the unconsolidated sequence consisted of sand and gravel. The St. Peter Sandstone was the first bedrock unit encountered in both boreholes. Borehole drilling just west of Area 9/10 (Phase II location MW116, at the intersection of 23rd Avenue and 4th Street;

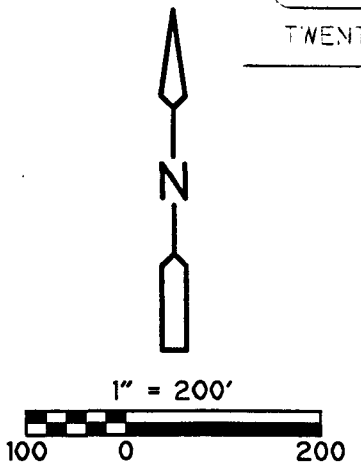
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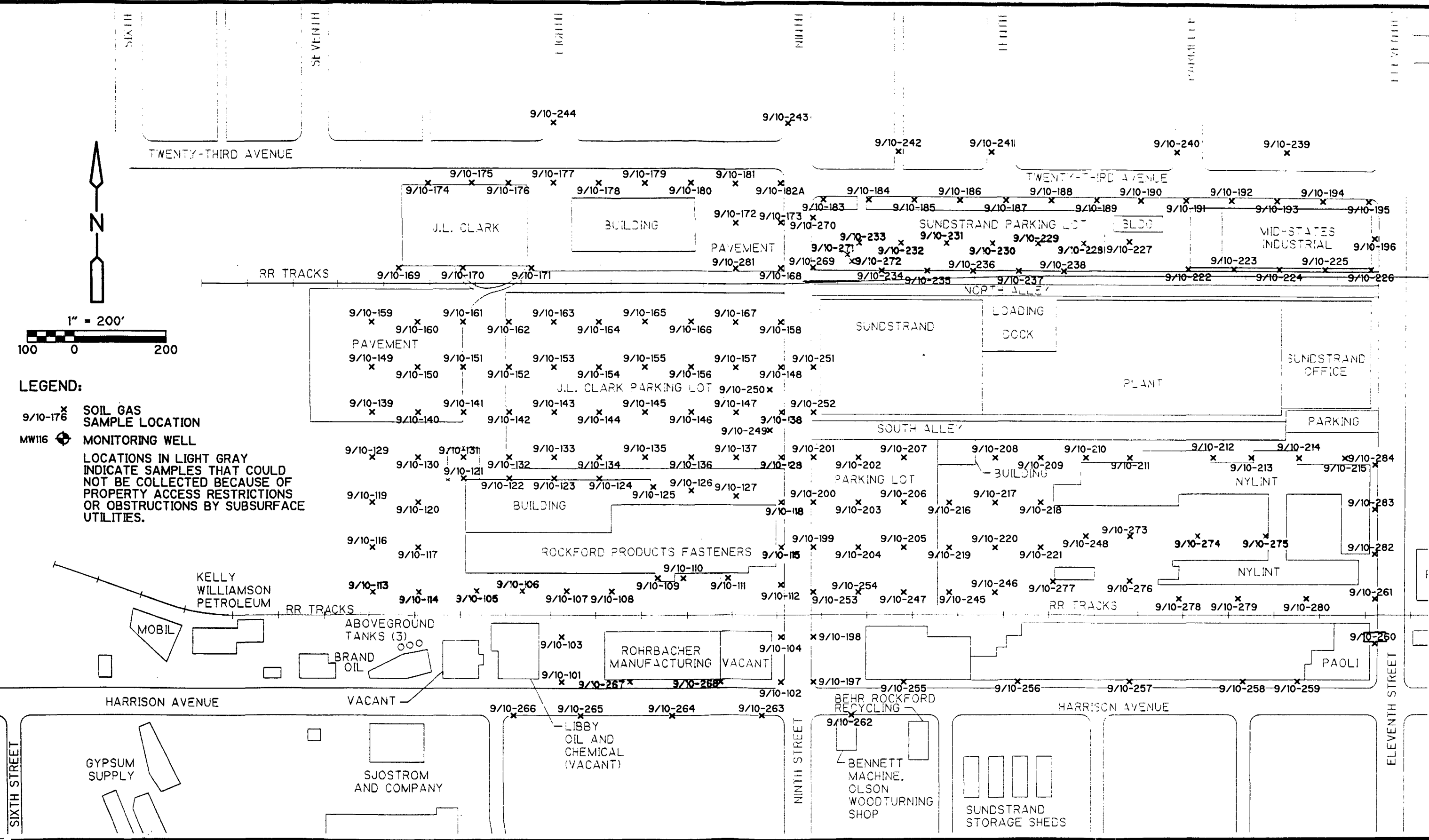


LEGEND:

9/10-176 x SOIL GAS SAMPLE LOCATION

MW116 ⊕ MONITORING WELL

LOCATIONS IN LIGHT GRAY INDICATE SAMPLES THAT COULD NOT BE COLLECTED BECAUSE OF PROPERTY ACCESS RESTRICTIONS OR OBSTRUCTIONS BY SUBSURFACE UTILITIES.



SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
**AREA 9/10 SOIL GAS
SAMPLE LOCATIONS**
Figure No. 3-26

boring log given in CDM 1995) indicated that the unconsolidated sediments are at least 169 feet thick, with a 12-foot thick clay unit from 132 to 144 feet below ground surface (CDM 1995). Bedrock was not encountered at location MW116. The surface topography of Area 9/10 is essentially flat, with a mean ground surface elevation of approximately 730 feet (USGS 1976). The water table is generally between 30 and 35 feet deep.

3.4.2 Results of SCOU Investigation -- Area 9/10

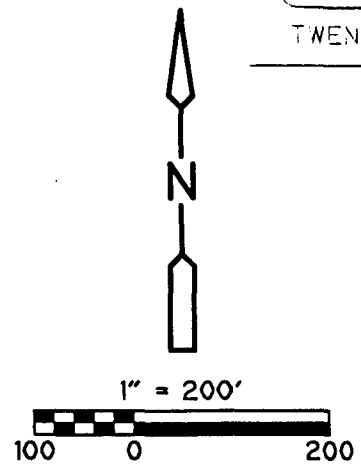
Soil Gas

The SCOU soil gas investigation identified several portions of Area 9/10 with anomalously high soil gas concentrations. The anomalous areas are 1) west and northwest of the Sundstrand plant (i.e. the southeast corner of 23rd Avenue and 9th Street); 2) immediately south of the Sundstrand Plant and in the Rockford Products parking lot; 3) immediately north of the Rockford Products building on 9th Street; 4) at the west end of the Nylint building; 5) at the Mid-States Industrial facility; and 6) the intersection of 9th Street and Harrison Avenue. Soil gas anomalies included the chlorinated hydrocarbons PCE, TCE, TCA, 1,2-DCE, 1,1-DCA, and vinyl chloride, as well as the non-chlorinated VOCs benzene, ethylbenzene, toluene, and xylene (BETX). Among the chlorinated VOCs, TCA was the most abundant soil gas analyte and vinyl chloride the least abundant, the latter being detected in only two samples. BETX compounds were ubiquitous in small to moderate amounts. The majority of soil gas detections were limited to the area south of 23rd Avenue and north of Harrison Avenue. Figure 3-26 shows the locations of the soil gas samples and Figures 3-27 through 3-31 show the soil gas results for PCE, TCE TCA, total chlorinated VOCs, and total BETX, respectively. Complete soil gas data are given in Appendix E.

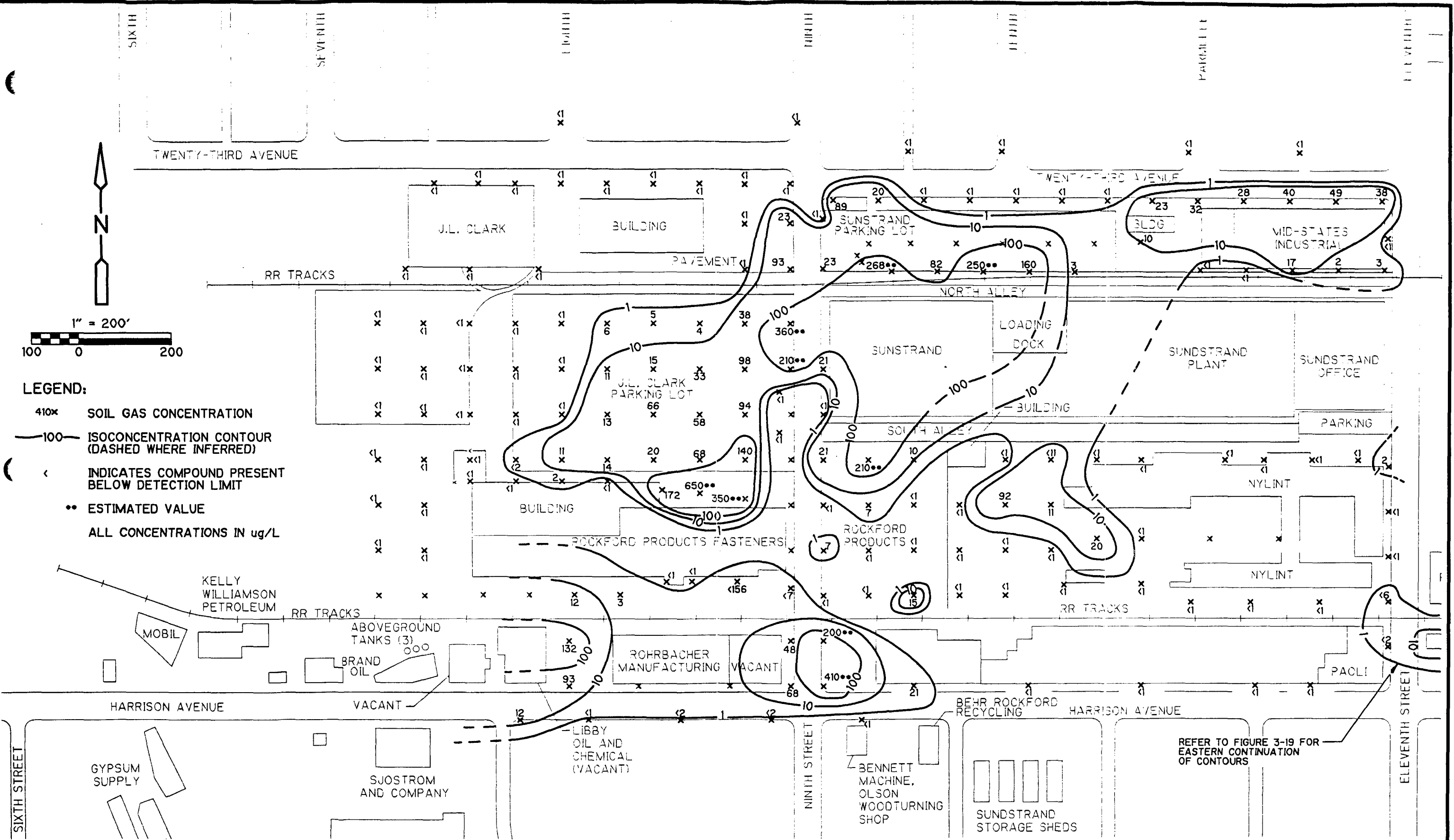
The soil gas distribution for PCE (Figure 3-27) indicates the presence of significant concentrations ($> 100 \mu\text{g/L}$) on the northwest, west, and southwest sides of the Sundstrand Plant on 9th Street, as well as in the area just north of Rockford Products, at the intersection of 9th Street and Harrison Avenue, and 500 feet west of this intersection on the north side of Harrison Avenue. Smaller PCE concentrations ($\leq 100 \mu\text{g/L}$) are present at the west end of the Nylint building and at the Mid-States Industrial facility.

TCE concentrations greater than $100 \mu\text{g/L}$ were found at the southwest corner of the Mid-States building, just north of the Rockford Products building, and at the west end of the Nylint building (Figure 3-28). TCE concentrations between 10 and $100 \mu\text{g/L}$ were detected at the intersection of 9th Street and Harrison Avenue, and just north of the loading dock area at the Sundstrand facility.

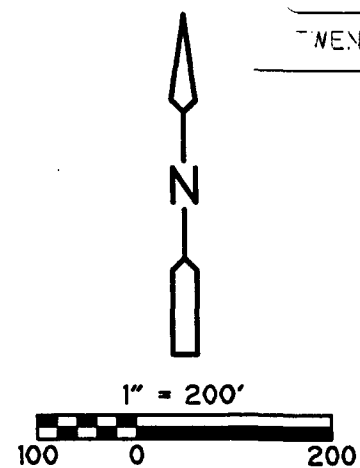
TCA concentrations are the most significant and pervasive of any soil gas compound in Area 9/10, as shown by the $1,000 \mu\text{g/L}$ contour line on Figure 3-29. The largest area of elevated TCA ($> 1,000 \mu\text{g/L}$) occurs just south of the west part of Sundstrand Plant #1, extending south-southwest across the Rockford Products parking lot.



- LEGEND:**
- 410x SOIL GAS CONCENTRATION
 - 100 ISOCONCENTRATION CONTOUR (DASHED WHERE INFERRED)
 - < INDICATES COMPOUND PRESENT BELOW DETECTION LIMIT
 - ESTIMATED VALUE
 - ALL CONCENTRATIONS IN ug/L

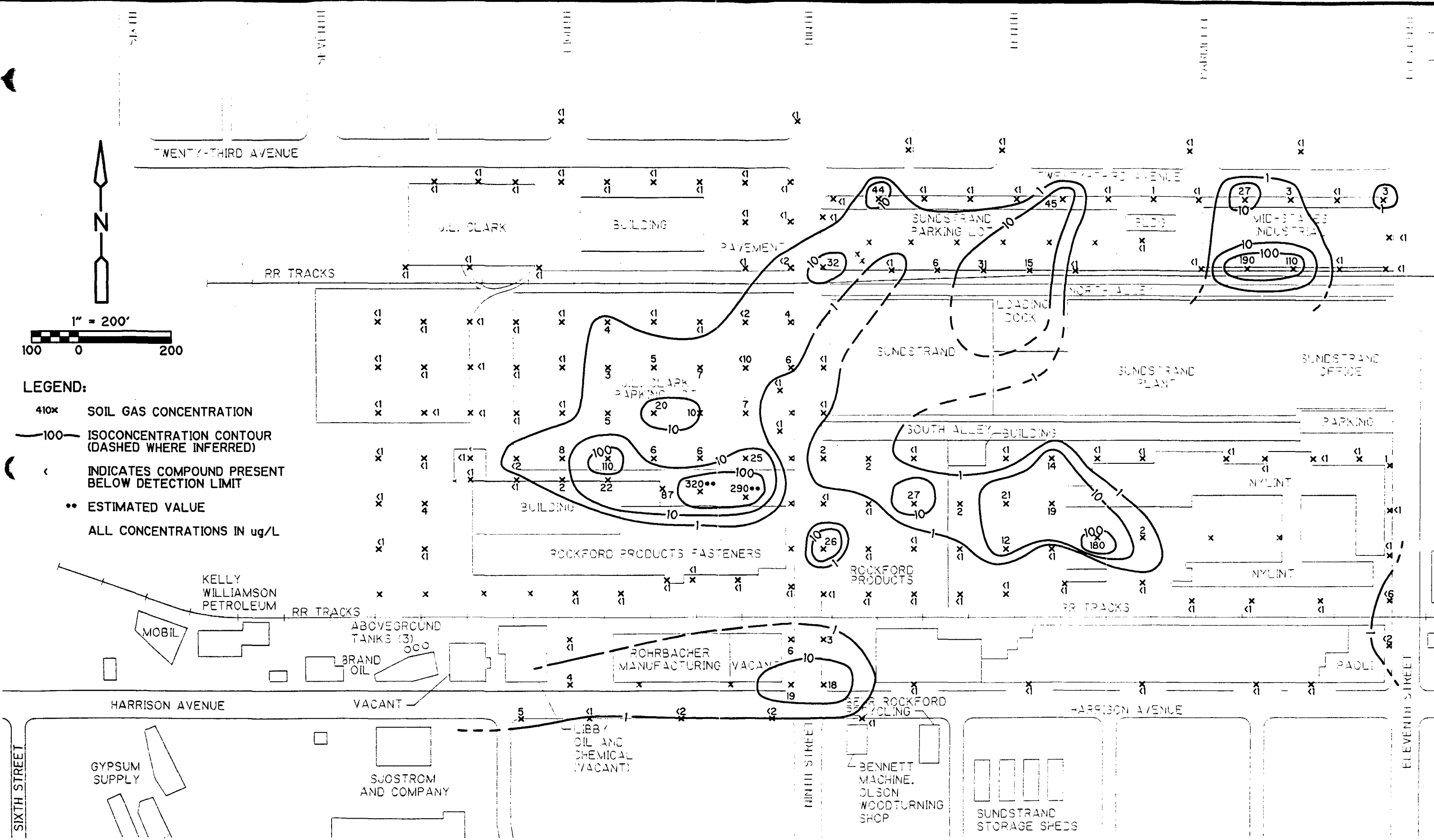


SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
AREA 9/10 SOIL GAS RESULTS
FOR PCE



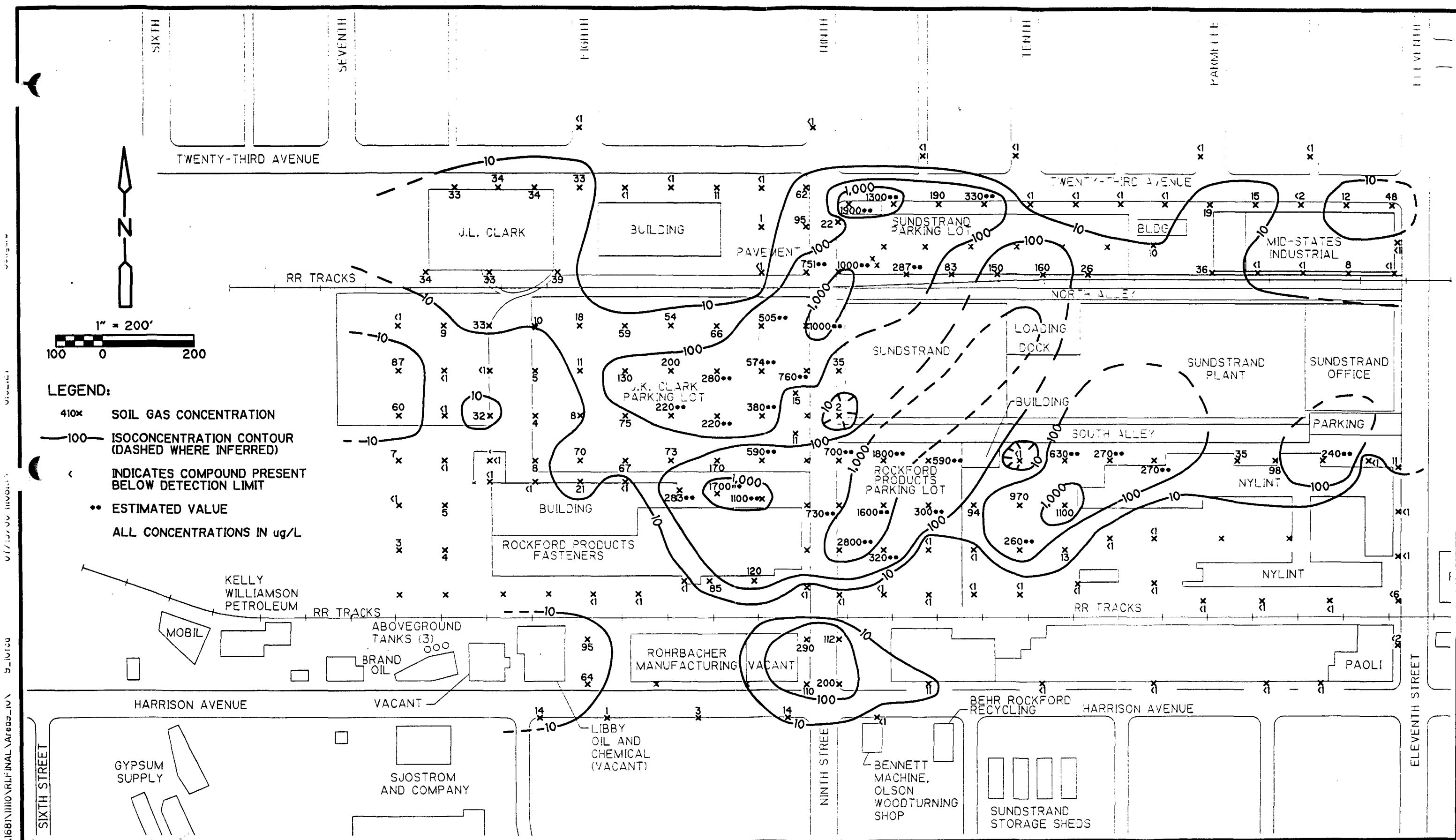
LEGEND:

- 410x SOIL GAS CONCENTRATION
- 100 ISOCONCENTRATION CONTOUR (DASHED WHERE INFERRED)
- < INDICATES COMPOUND PRESENT BELOW DETECTION LIMIT
- ** ESTIMATED VALUE
- ALL CONCENTRATIONS IN ug/L



SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
AREA 9/10 SOIL GAS RESULTS
FOR TCE

Figure No. 3-28



SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
AREA 9/10 SOIL GAS RESULTS
FOR TCA

Elevated TCA was also found north and northwest of the Sundstrand Plant #1, north of the Rockford Products facility, and at the west end of the Nylint building. Relatively lower concentrations of TCA (10 to 100 µg/L) were detected at the intersection of 9th Street and Harrison Avenue and northeast of Nylint. The distribution of total chlorinated VOCs (Figure 3-30) is similar to that of TCA, with elevated levels (> 1,000 µg/L) found south and northwest of Sundstrand, north of Rockford Products, and west of the Nylint facility. Three additional areas of chlorinated VOCs include the area northeast of Nylint, at the intersection of 9th Street and Harrison Avenue, and between Rohrbacher Manufacturing and the former Libby Oil and Chemical facility.

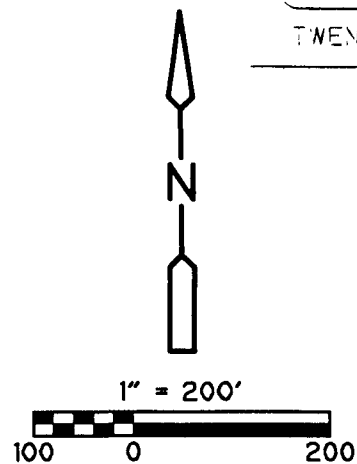
The soil gas distributions for 1,2-DCE and 1,2-DCA are similar to that of TCA. The soil gas data for these two compounds are given in Appendix E. It should be noted that the only two detections of vinyl chloride in soil gas occurred near the intersection of 9th Street and Harrison Avenue, in samples SG9/10-101 (56 µg/L) and SG9/10-104 (27 µg/L).

The BETX compounds in Area 9/10 soil gas differ from the total chlorinated VOCs in that the total BETX concentrations are lower (typically less than 500 µg/L), and they display a somewhat different spatial distribution (Figure 3-31). Three areas of high BETX (> 100 µg/L) include the north side of the Mid-States facility extending west along 23rd Avenue to the Sundstrand parking lot, the area just north of the intersection of 9th Street and Harrison Avenue, and scattered locations west of 9th Street in the J. L. Clark parking lot. The large BETX concentration east of Nylint is related to Area 11 and is discussed in Section 3.3 of this report.

Subsurface Soil

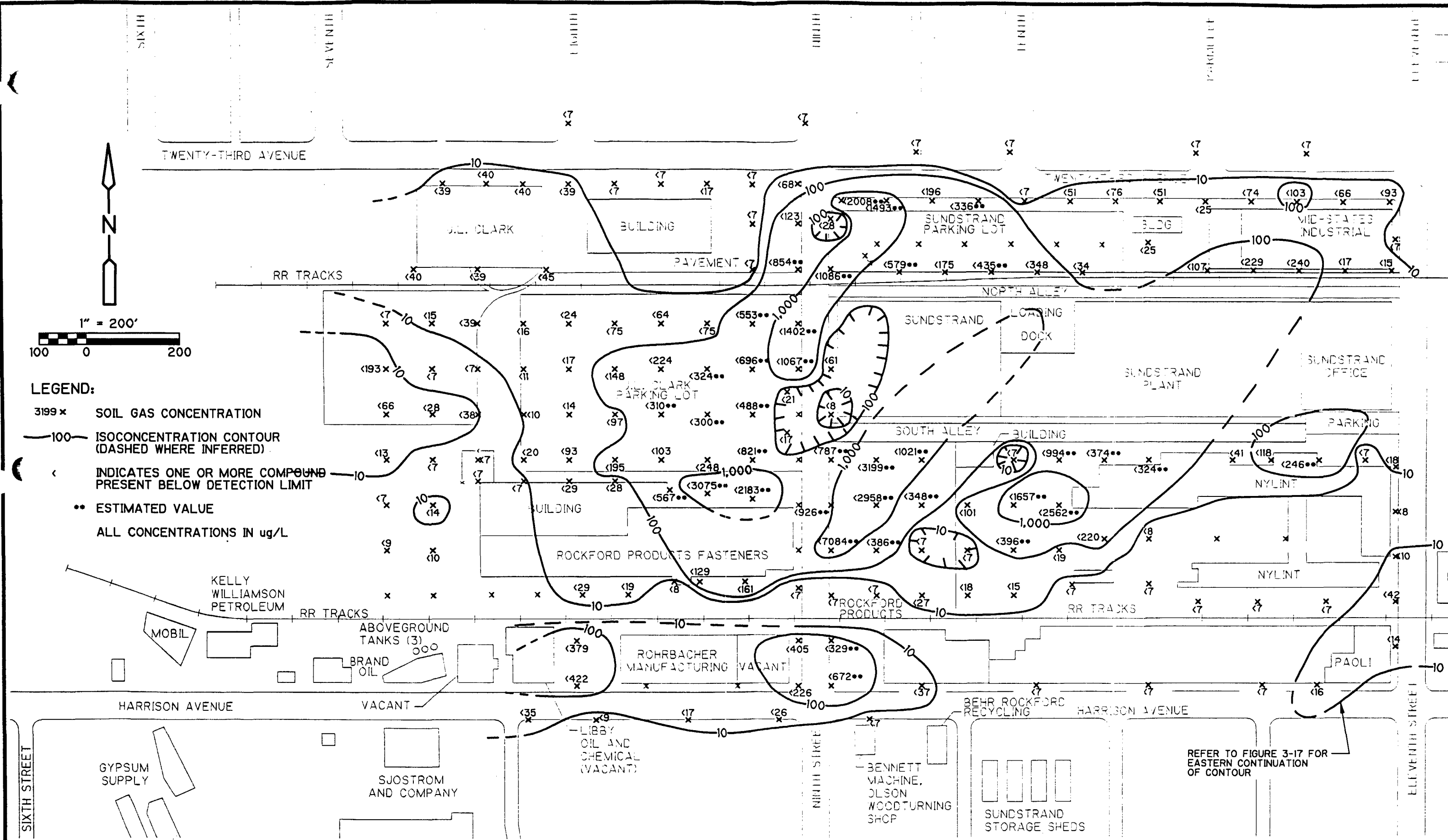
In areas where access was attainable, analytical results for Area 9/10 subsurface soils show low concentrations of total chlorinated VOCs. In the unsaturated zone, a maximum of 50 µg/kg of total VOCs was found, and up to 154 µg/kg total VOCs were detected in soil from the top 10 feet of the saturated zone. The frequency of detection for chlorinated VOCs typically did not exceed 5% of all samples, both above and below the water table (Table 3-13). Toluene was detected in 17% of the samples, with a maximum concentration of 18 µg/kg. Acetone and methylene chloride were detected in 16% and 25% of all samples, respectively. Neither acetone nor methylene chloride exceeded 50 µg/kg in any sample.

The only detections of chlorinated VOCs in soil above the water table occurred at the Sundstrand Plant in borings SB9/10-134, -135, and -137. Boring locations are shown on Figure 3-32 and the analytical results are summarized on Figure 3-33. The largest concentration of chlorinated VOCs in soils from the saturated zone was in SB9/10-205, which had 154 µg/kg at a depth of 39 to 41 feet below ground surface (i.e. 7 to 9 feet below the water table). VOCs were also found in the saturated zone in borings SB9/10-201 (10 µg/kg, 43 to 45 feet bgs; mainly TCA and 1,2-DCE) and SB9/10-203 (9 µg/kg, 43 to 45 feet bgs; mainly PCE). Note that Figure 3-33 shows data for only some



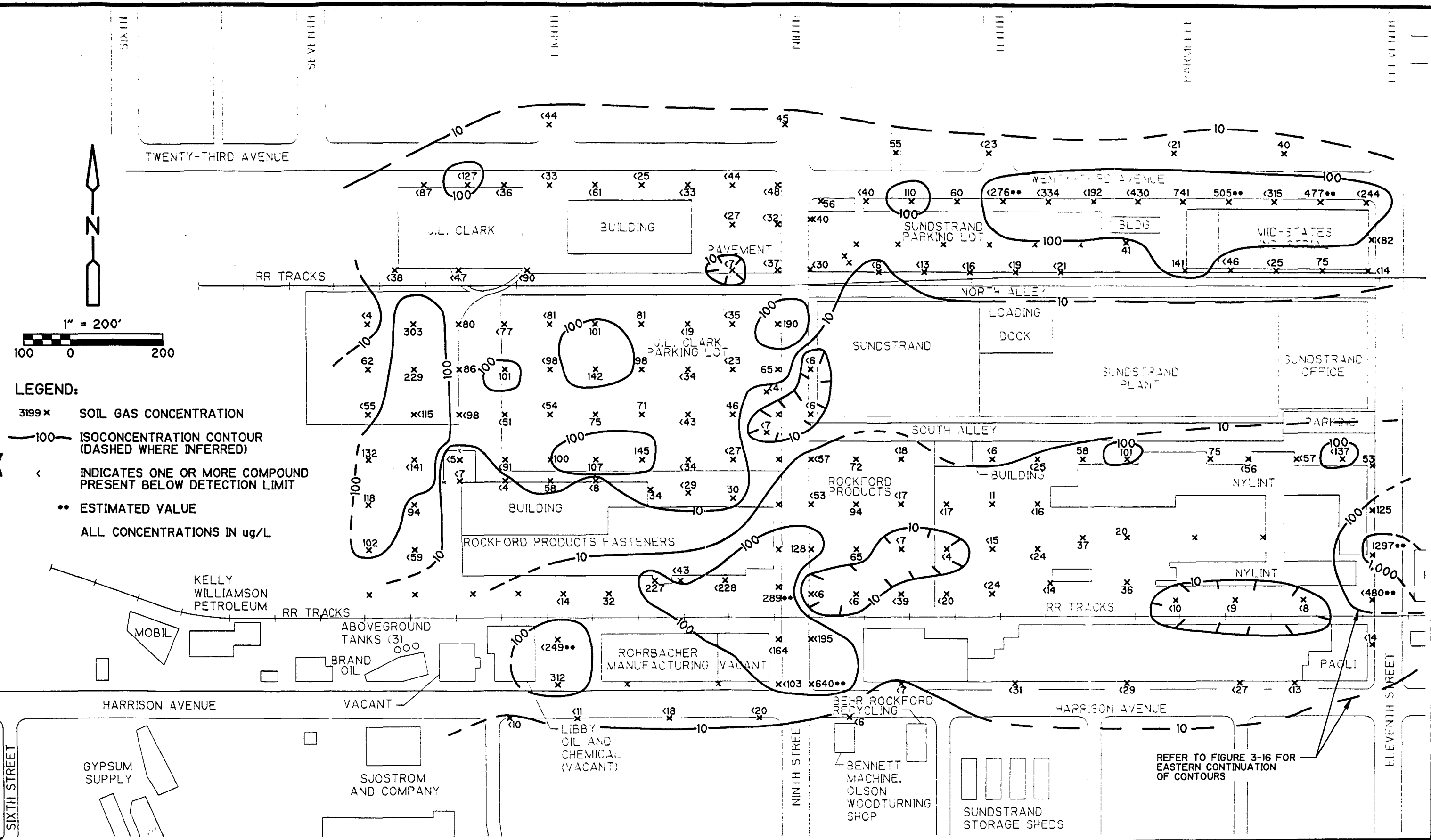
LEGEND:

- 3199 x SOIL GAS CONCENTRATION
- 100 ISOCONCENTRATION CONTOUR (DASHED WHERE INFERRED)
- < INDICATES ONE OR MORE COMPOUNDS PRESENT BELOW DETECTION LIMIT
- ** ESTIMATED VALUE
- ALL CONCENTRATIONS IN ug/L



SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
**AREA 9/10 SOIL GAS RESULTS
FOR TOTAL CHLORINATED VOCs**
Figure No. 3-30

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SOUTHEAST ROCKFORD SOURCE CONTROL
OPERABLE UNIT
AREA 9/10 SOIL GAS RESULTS
FOR TOTAL BTEX
Figure No. 3-31

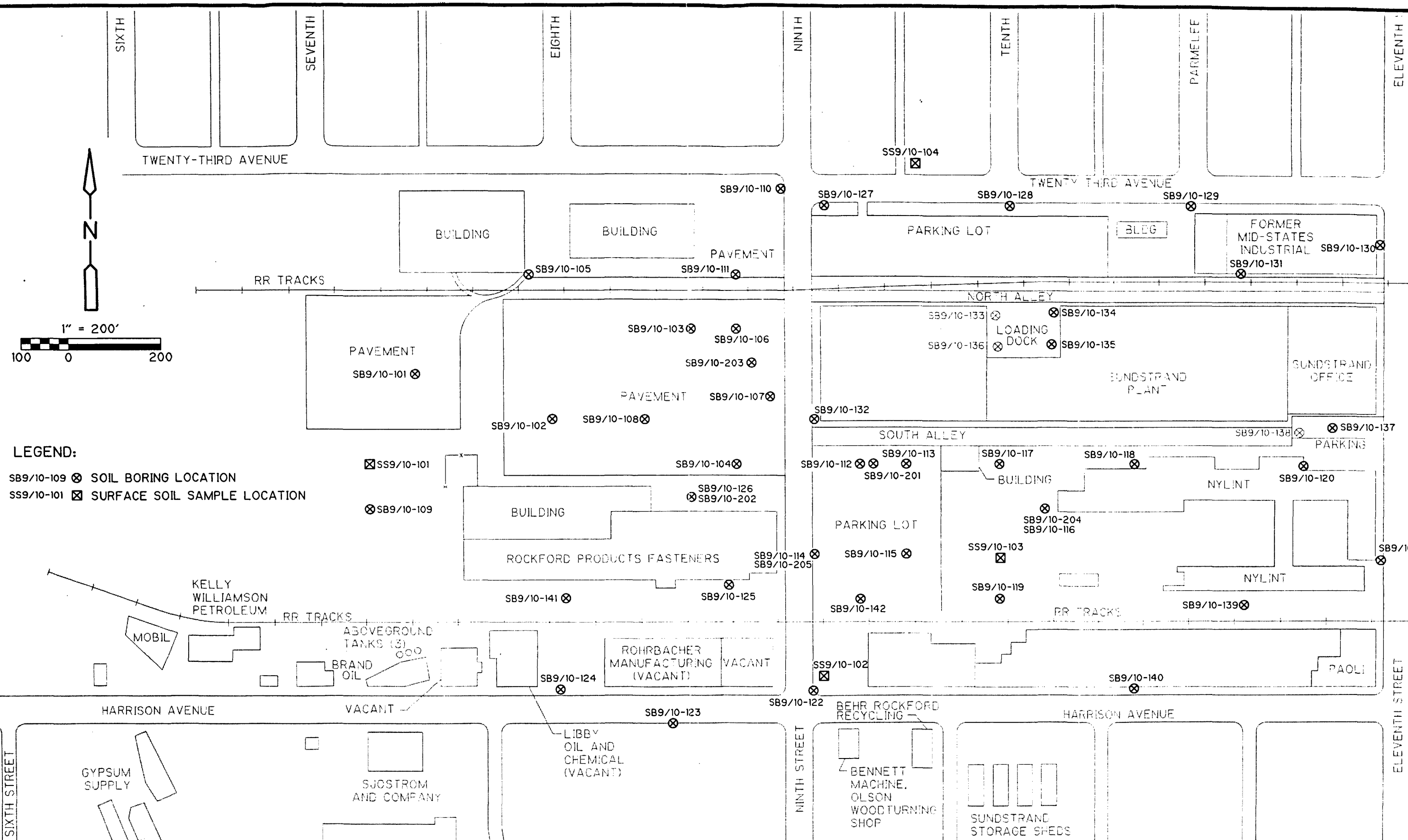
Table 3-13

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Sub-surface Soil Boring Sample Analysis - Area 9/10

Parameter	Organic Soil Boring Samples - Area 9/10	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
Methylene Chloride	3 - 48	22 / 87 (25%)
Acetone	2 - 11	14 / 87 (16%)
1,1-Dichloroethene	2 - 2	1 / 87 (1%)
1,2-Dichloroethene (total)	5 - 86	2 / 87 (2%)
2-Butanone	4 - 5	4 / 87 (5%)
1,1,1-Trichloroethane	1 - 50	4 / 87 (5%)
Trichloroethene	1 - 2	4 / 87 (5%)
1,1,2-Trichloroethane	6 - 6	1 / 87 (1%)
Tetrachloroethene	2 - 46	5 / 87 (6%)
Toluene	1 - 18	15 / 87 (17%)
Xylene	4 - 4	1 / 87 (1%)
<u>Semivolatile Organics (ug/Kg)</u>		
Acenaphthene	220 - 220	1 / 23 (4%)
Dibenzofuran	150 - 150	1 / 23 (4%)
Fluorene	120 - 120	1 / 23 (4%)
bis(2-Ethylhexyl)Phthalate	44 - 6900	5 / 23 (22%)
<u>Pesticides & PCBs (ug/Kg)</u>		
gamma-BHC (Lindane)	2.3 - 2.3	1 / 23 (4%)
Endrin	3.8 - 3.8	1 / 23 (4%)
4,4'-DDT	6.4 - 6.4	1 / 23 (4%)

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SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
AREA 9/10 SOIL BORING AND
SURFACE SOIL SAMPLE LOCATIONS
Figure No. 3-32

LEGEND:

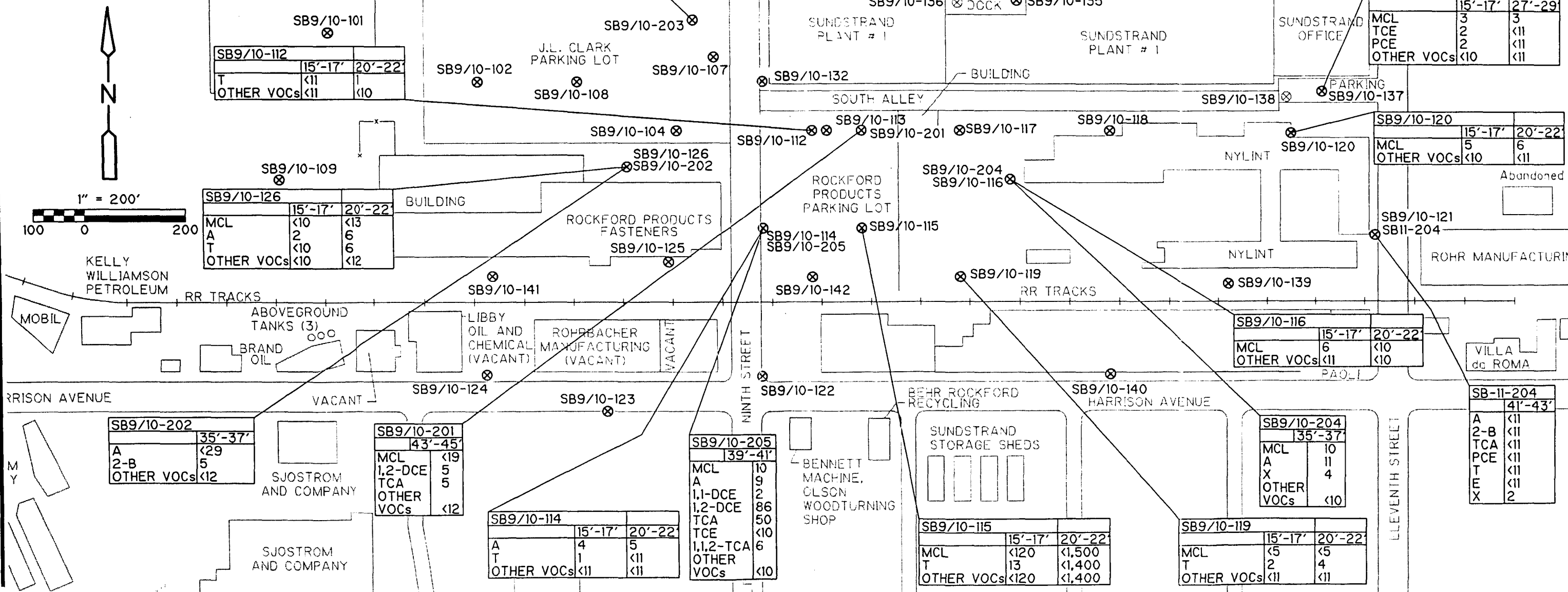
⊗ SOIL BORING

ABBREVIATIONS:

MCL
A
1,1-DCE
1,2-DCE
2-B
TCA
TCE
1,1,2-TCA
PCE
T
X
OTHER VOCs
<10

METHYLENE CHLORIDE
ACETONE
1,1-DICHLOROETHENE
1,2-DICHLOROETHENE
2-BUTANONE
1,1,1-TRICHLOROETHANE
TRICHLOROETHENE
1,1,2-TRICHLOROETHANE
TETRACHLOROETHENE
TOLUENE
XYLENE
INDICATES ALL OTHER VOCs INDIVIDUAL
UNDETECTED AT METHOD DETECTION LIMIT

ALL DEPTHS ARE GIVEN IN FEET BELOW GROUND SURFACE
ALL CONCENTRATIONS IN ug/kg



SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
AREA 9/10 SUBSURFACE SOIL DATA
FOR SELECTED LOCATIONS

Figure No. 3-33

of the borings advanced in Area 9/10 to minimize the clutter on the figure. All of the data for subsurface soil samples are given in Appendix E and the hits are shown on Figure E-1, a large format (24" by 36") drawing on the inside back cover of this report.

Table 3-14 lists the frequency and range of detections for inorganic analytes in subsurface soils from Area 9/10. The metal analytes in Area 9/10 subsurface soils fall within the observed range of concentrations for soils in the eastern United States (Shacklette and Boerngen, 1984).

Surface Soil

Surface soil samples were collected from four locations in Area 9/10, as shown on Figure 3-32. The only VOC detected was methylene chloride, a common laboratory contaminant, at less than 5 µg/kg (Table 3-15). A total of 20 SVOCs were detected, including phenanthrene, fluoranthene, pyrene, and chrysene. The most frequent pesticide detections were dieldrin and gamma-Chlordane, which were found in two of the four surface soil samples. Table 3-16 lists the frequency of detection for the inorganic analytes in surface soils. The metal analytes in Area 9/10 surface soils fall within the observed range of concentrations for soils in the eastern United States (Shacklette and Boerngen, 1984).

Groundwater

Five of the groundwater monitoring wells shown on Figure 3-34 were sampled and analyzed for VOCs and the results of the chemical analysis are also presented on the same figure and in Table 3-17. MW201, 202, and 203 were installed during the SCOU investigation, and MW4 and MW5 were installed on the Mid-States (formerly Rockford Power Machinery) property in 1991 for a previous study (Fehr-Graham & Associates, 1991). Eight VOCs were detected in the groundwater samples, with the largest concentrations (> 18,000 µg/L total VOCs) and the greatest number of detections occurring in MW201; relatively smaller VOC concentrations were found in the other four wells (< 50 µg/L total VOCs). TCA (12,000 µg/L) was the most abundant compound detected in MW201, followed by 1,2-DCE (4,500 µg/L), 1,1-DCE (850 µg/L), and 1,1-DCA (690 µg/L). Monitoring wells MW202 and MW203 had the fewest number of detections and the lowest concentrations of the five sampled wells. MW4 had TCE (40 µg/L) as the most abundant VOC, while PCE (20 µg/L) was dominant in MW5. The levels of TCA in MW4, MW202, and MW203 were similar to the equipment blank.

Water level measurements in monitoring wells within and adjacent to Area 9/10 indicate that groundwater in the upper part of the unconsolidated aquifer flows toward the southwest (Table 3-18 and Figure 3-35). Accordingly, MW202 and MW203 are located upgradient of Mid-States Industrial and Sundstrand Plant #1, and MW201 and MW127 are located downgradient. This flow direction is consistent with that determined during the Phase II investigation (CDM 1995), although the present study has greater resolution in the Mid-States/Sundstrand area because of the increased

Table 3-14

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table -Inorganic Sub-surface Soil Boring Sample Analysis - Area 9/10

Parameter	Inorganic Soil Boring Samples - Area 9/10	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	836 - 1180	4 / 4 (100%)
Antimony	3.8 - 4.5	2 / 4 (50%)
Arsenic	0.67 - 0.91	4 / 4 (100%)
Barium	4.5 - 5.3	4 / 4 (100%)
Beryllium	0.06 - 0.09	3 / 4 (75%)
Cadmium	0.07 - 0.1	2 / 4 (50%)
Calcium	42900 - 71100	4 / 4 (100%)
Chromium	3.1 - 5.3	4 / 4 (100%)
Cobalt	1.2 - 1.6	4 / 4 (100%)
Copper	2.8 - 6.3	4 / 4 (100%)
Iron	2600 - 3530	4 / 4 (100%)
Lead	1.5 - 2	4 / 4 (100%)
Magnesium	17100 - 29000	4 / 4 (100%)
Manganese	79.6 - 123	4 / 4 (100%)
Nickel	3.1 - 3.6	4 / 4 (100%)
Potassium	111 - 215	4 / 4 (100%)
Sodium	65.2 - 151	4 / 4 (100%)
Thallium	0.16 - 0.65	4 / 4 (100%)
Vanadium	4.2 - 7.2	4 / 4 (100%)
Zinc	6.6 - 9.1	4 / 4 (100%)
Cyanide	0.17 - 5.5	3 / 4 (75%)

Table 3-15

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Organic Surface Soil Analysis - Area 9/10

Parameter	Organic Surface Soils - Area 9/10	
	Range of Samples With Detections, ppb	Proportion of Samples With Detections
<u>Volatile Organics (ug/Kg)</u>		
Methylene Chloride	2 - 3	2 / 4 (50%)
<u>Semivolatile Organics (ug/Kg)</u>		
Naphthalene	320 - 320	1 / 4 (25%)
2-Methylnaphthalene	250 - 250	1 / 4 (25%)
Acenaphthene	200 - 350	2 / 4 (50%)
Dibenzofuran	190 - 190	1 / 4 (25%)
Fluorene	190 - 340	2 / 4 (50%)
Phenanthrene	400 - 3600	4 / 4 (100%)
Anthracene	55 - 640	4 / 4 (100%)
Carbazole	59 - 530	4 / 4 (100%)
Di-n-Butylphthalate	1200 - 1600	2 / 4 (50%)
Fluoranthene	650 - 4800	4 / 4 (100%)
Pyrene	580 - 4200	4 / 4 (100%)
Butylbenzylphthalate	60 - 660	2 / 4 (50%)
Benzo(a)anthracene	330 - 2300	4 / 4 (100%)
Chrysene	310 - 2100	4 / 4 (100%)
bis(2-Ethylhexyl)Phthalate	130 - 7400	4 / 4 (100%)
Benzo (b) Fluoranthene	420 - 2800	4 / 4 (100%)
Benzo (k) Fluoranthene	220 - 890	4 / 4 (100%)
Benzo (a) Pyrene	260 - 1700	4 / 4 (100%)
Ideno (1,2,3-cd) Pyrene	230 - 1300	4 / 4 (100%)
Benzo (g,h,i) Perylene	270 - 1400	4 / 4 (100%)
<u>Pesticides & PCBs (ug/Kg)</u>		
Heptachlor epoxide	2.5 - 2.5	1 / 4 (25%)
Dieldrin	4.1 - 54	2 / 4 (50%)
4,4'-DDE	17 - 17	1 / 4 (25%)
4,4'-DDD	7.1 - 7.1	1 / 4 (25%)
4,4'-DDT	7 - 41	2 / 4 (50%)
gamma-Chlordane	2 - 2	1 / 4 (25%)
Aroclor-1254	30 - 30	1 / 4 (25%)
Endrin	0 - 0	0 / 4 (0%)
Endosulfan II	0 - 0	0 / 4 (0%)
4,4'-DDD	0 - 0	0 / 4 (0%)
4,4'-DDT	0 - 0	0 / 4 (0%)
Methoxychlor	0 - 0	0 / 4 (0%)
Endrin ketone	0 - 0	0 / 4 (0%)
Endrin aldehyde	0 - 0	0 / 4 (0%)
alpha-Chlordane	0 - 0	0 / 4 (0%)
gamma-Chlordane	0 - 0	0 / 4 (0%)
Aroclor-1254	0 - 0	0 / 4 (0%)

Table 3-16

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Hits Table - Inorganic Surface Soil Sample Analysis - Area 9/10

Parameter	Inorganic Surface Soils - Area 9/10	
	Range of Samples With Detections, ppm	Proportion of Samples With Detections
<u>Inorganics (mg/Kg)</u>		
Aluminum	3220 - 11800	4 / 4 (100%)
Arsenic	1.9 - 25	4 / 4 (100%)
Barium	37.4 - 153	4 / 4 (100%)
Beryllium	0.1 - 0.23	4 / 4 (100%)
Cadmium	0.47 - 0.95	2 / 4 (50%)
Calcium	6430 - 50100	4 / 4 (100%)
Chromium	5.6 - 16.2	4 / 4 (100%)
Cobalt	2.5 - 6.1	4 / 4 (100%)
Copper	9.9 - 44.5	4 / 4 (100%)
Iron	6120 - 16600	4 / 4 (100%)
Lead	27.4 - 209	4 / 4 (100%)
Magnesium	3840 - 28800	4 / 4 (100%)
Manganese	225 - 649	4 / 4 (100%)
Mercury	0.07 - 0.09	2 / 4 (50%)
Nickel	4.3 - 10.8	4 / 4 (100%)
Potassium	363 - 1440	4 / 4 (100%)
Sodium	28.4 - 130	4 / 4 (100%)
Vanadium	10.3 - 27.2	4 / 4 (100%)
Zinc	43.8 - 287	4 / 4 (100%)
Cyanide	0.12 - 0.21	3 / 4 (75%)

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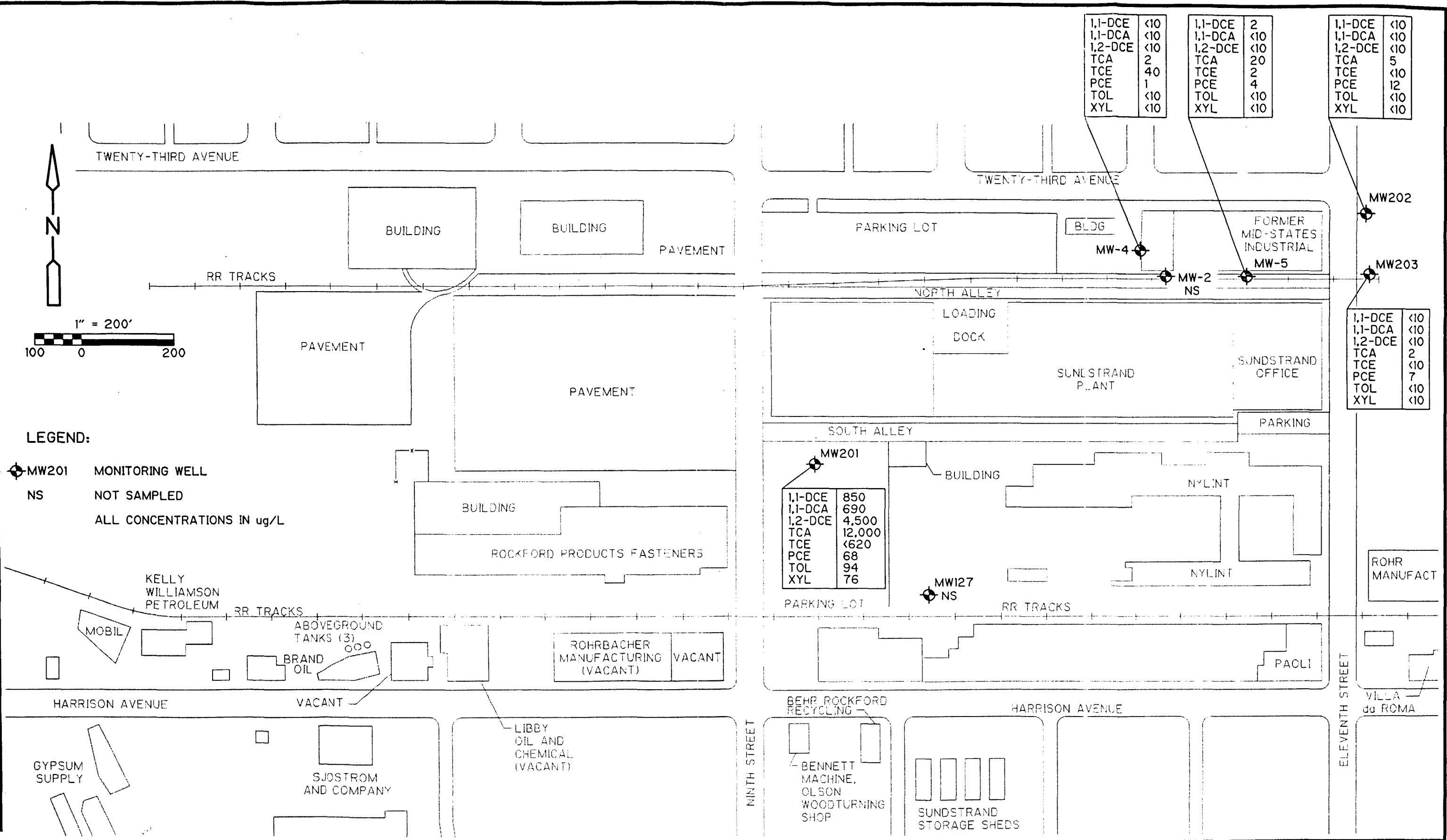


Table 3-17

Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

Groundwater Chemical Data for Area 9/10
Collected July 1996

Date Sampled	07/16/1996	07/16/1996	07/16/1996	07/17/1996	07/16/1996	07/16/1996	07/16/1996
Sample Number	MW201	MW202	MW203	MW4	MW5	EQUIP. BLANK	TRIP BLANK
Organic Tracking Number							

Volatile Organic Compounds (ug/L)

1,1-Dichloroethene	850	10 U	10 U	10 U	2 J	10 U	10 U
1,1-Dichloroethane	690	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	4500	10 U	10 U	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane	12000	5 J	2 J	2 J	20	2 J	10 U
Trichloroethene	620 U	10 U	10 U	40	2 J	10 U	10 U
Tetrachloroethene	68 J	12	7 J	1 J	4 J	10 U	10 U
Toluene	94 J	10 U	10 U	10 U	10 U	10 U	10 U
Xylene (total)	76 J	10 U	10 U	10 U	10 U	10 U	10 U

Total VOCs	18278	17	9	43	28	2	
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QUALIFIERS

U: Not Detected; J: Estimated Value

Table 3-18

Southeast Rockford
Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit Investigation

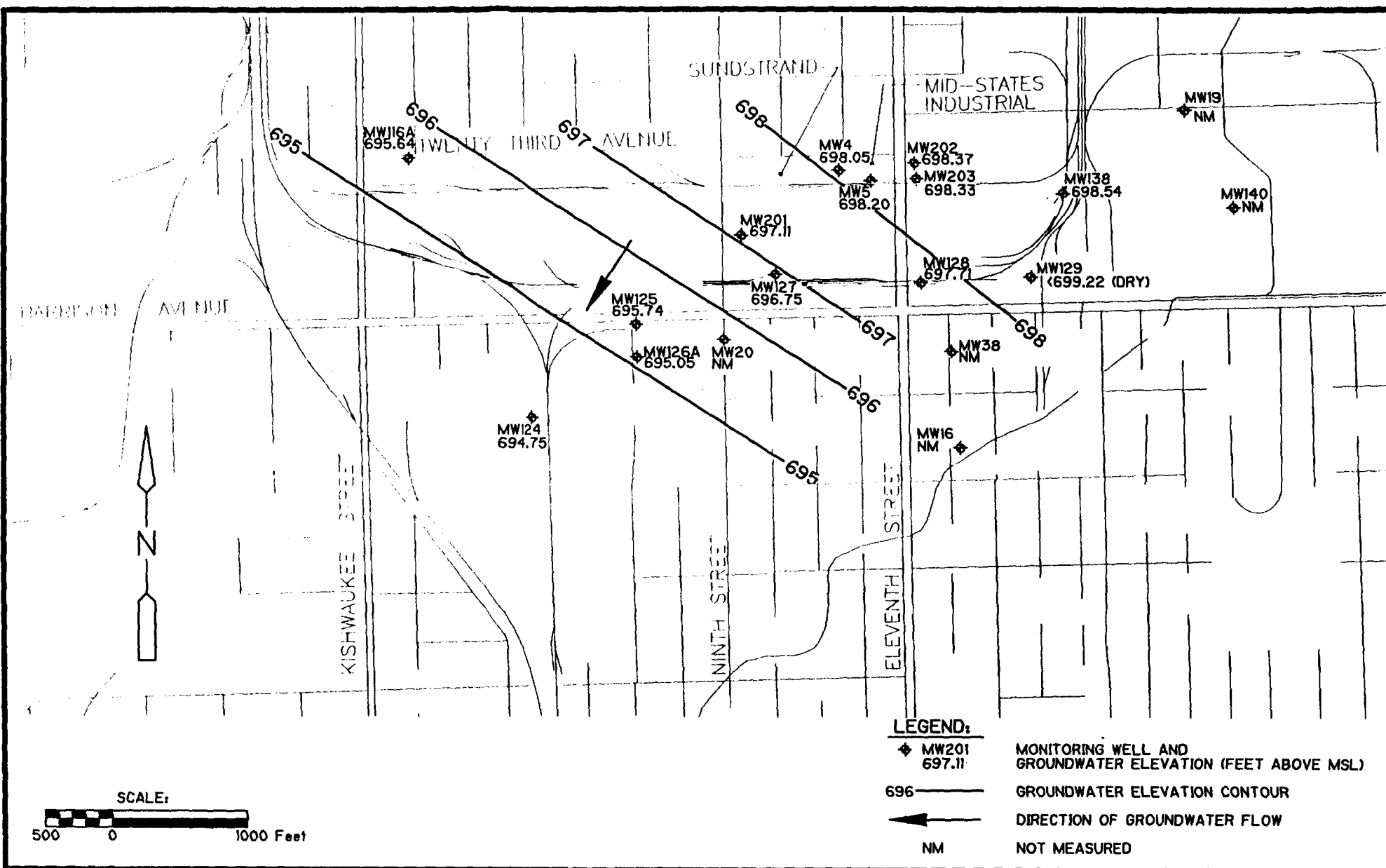
Groundwater Elevations
July 16-17, 1996

WELL	ELEVATION (ft.)		DEPTH TO WATER (ft.) ¹ July 16-17, 1996	WATER TABLE ELEVATION (ft.) July 16-17, 1996
	GROUND	TOP OF CASING		
MW-201	729.3	729.03	31.92	697.11
MW-202	729.5	729.62	31.25	698.37
MW-203	729.6	729.09	30.76	698.33
MW-4	728.5	728.10	30.05	698.05
MW-5	729.6	729.40	31.20	698.20
MW-116A	733.7	736.24	40.60	695.64
MW-125	727.9	727.31	31.57	695.74
MW-126A	727.9	727.62	32.57	695.05
MW-124	729.0	731.30	36.55	694.75
MW-127	726.2	728.59	31.84	696.75
MW-128	728.8	728.40	30.69	697.71
MW-129	732.1	732.12	32.9 (DTB)	< 699.22 (Dry)
MW-138	732.3	734.79	36.25	698.54

¹ Measured from top of inner casing

NM Not Measured

DTB Depth to Bottom



SOUTHEAST ROCKFORD
SOURCE CONTROL OPERABLE UNIT
AREA 9/10 GROUNDWATER ELEVATIONS
IN THE UNCONSOLIDATED AQUIFER,
JULY 16-17, 1996

Figure No. 3-35

CDM

environmental engineers, scientists,
planners, & management consultants

coverage provided by the Mid-States wells and the three wells installed during the SCOU investigation.

3.4.3 Discussion -- Area 9/10

Results of the SCOU investigation indicate that significant sources of VOC contamination exist within Area 9/10, based on the distribution and magnitude of soil gas, subsurface soil, and groundwater concentrations. Potential source locations include Sundstrand Plant #1, the Mid-States Industrial property, the western part of the Nylint building, and the Rockford Products property. Furthermore, groundwater VOC concentrations in MW201 suggest that NAPL is present in Area 9/10.

Sundstrand Plant #1

The pattern and magnitude of VOCs in soil gas suggest that the vapors emanate from the vicinity of the Plant #1 building (Figures 3-27 to 3-30), especially for PCE and TCA, which show high values on the north, west, and south sides of the western portion of Plant #1. Where access was obtained, soil borings advanced in these areas of high soil gas values did not encounter elevated VOCs (e.g. SB9/10-127, -203, -112, -113, -201, and -205; refer to Figure 3-33). Chlorinated VOCs were found in the three borings placed on the Sundstrand property (SB9/10-134, -135, and -137) at concentrations up to 46 µg/kg of PCE, 2 µg/kg of TCE, and 2 µg/kg of TCA. Although these concentrations are relatively low compared with those observed in Source Areas 4, 7, and 11, they represent the largest values found in the unsaturated zone in Area 9/10. Slightly higher VOC concentrations were found in soils from below the water table (SB9/10-201, -203, and -205). These borings are located hydraulically downgradient of the Sundstrand property. Overall, the pattern of high soil gas hits and low soil concentrations is consistent with a source area, or areas, located under or near Plant #1.

Available information (104e Requests; Harding Lawson Associates 1992) regarding Plant #1 documents the existence of a potential source area at the facility. Soil data from the Outdoor Storage Area (OSA) formerly located at the southwest corner of the Sundstrand parking lot (9th Street and 23rd Avenue), had significantly elevated VOCs. From 1962 to 1985, the OSA was used to store several VOC-bearing materials, including PCE, TCA, toluene, xylene, acetone, and methylene chloride. In addition, an underground storage tank (UST) adjacent to the OSA was used to hold spills and runoff from the concrete lined trench that was part of the OSA. Information provided by

IEPA indicates that more than 3,000,000 µg/kg of PCE was found in soil beneath the OAS. This area represents a significant source of VOCs to groundwater and may explain the PCE and TCA distributions in soil gas and in soil boring SB9/10-203.

In addition to the OSA, the loading dock area at Plant #1 has contained approximately 14 USTs at various times between 1962 and 1987. These USTs were primarily steel

with a variety of contents, including solvents, cutting oils, fuel oil, and jet fuel (JP4). Solvents included PCE, new TCA, and waste TCA. It should be noted that the loading dock area is located roughly 500 feet upgradient of MW201, indicating that releases of chlorinated solvents such as TCA from the loading dock would be transported toward MW201. Moreover, volatilization of VOCs at the water table would produce the distribution of TCA and PCE in soil gas shown on Figure 3-29. Groundwater samples collected from MW201 during the SCOU investigation contained 68 µg/L of PCE and 12,000 µg/L of TCA (Figure 3-34).

A third potential source of VOC contamination at Plant #1 is the Waste Recycling Area (WRA) located inside the facility, approximately 150 to 200 feet east of the loading dock area. The WRA, which began operation in 1982, recovers TCA from liquid mixtures containing 90% TCA and 10% oil and grease. The WRA is located upgradient of the west end of the Nylint building and roughly downgradient of the former Mid-States Industrial facility.

Former Mid-States Industrial

A drum storage area at the former Mid-States Industrial facility (formerly Rockford Power Machinery) constitutes another potential source location in Area 9/10. TCE was the dominant VOC found in shallow soils (up to 67,000 µg/kg), with an average of 34,000 µg/kg for the four largest detections (Fehr-Graham Associates 1989). Other detected VOCs included PCE (7 - 74 µg/kg), TCA (<5 - 110 µg/kg), toluene (<5 - 21 µg/kg), xylene (<5 - 35 µg/kg), and ethylbenzene (<5 - 8 µg/kg). The presence of ETX in soil samples is consistent with total BETX in soil gas for this part of Area 9/10 (Figure 3-31).

Nylint

The SCOU investigation at the property leased by Nylint found large TCA (> 1,000 µg/L) concentrations in soil gas at the west end of the building, suggesting a potential nearby source. Soil samples, however, did not detect elevated VOCs of the magnitude observed at Areas 4, 7, and 11, indicating that soil gas is either migrating from an adjacent area(s) where soil samples were not collected, or that volatilization from the water table is responsible for the observed soil vapor distribution. Currently available information is not sufficient to distinguish between these two alternatives.

Rockford Products

A potential source location at the Rockford Products facility on 9th Street was indicated by elevated (> 1,000 µg/L) concentrations of VOCs in soil gas. Soil samples from borings SB9/10-126 and -202 did not contain chlorinated VOCs (Figure 3-33), indicating that vapors are either migrating from under the building or that volatilization from groundwater is responsible for the large soil gas hits. It should be noted that the area of elevated soil gas at Rockford Products is located hydraulically downgradient from the Outdoor Storage Area at Sundstrand Plant #1. VOC migration from the OSA and volatilization from the water table could produce the observed soil

gas distribution at Rockford Products. Currently available information is not sufficient to distinguish between a VOC source at the Rockford Products facility and migration/volatilization from an upgradient source.

NAPL in Area 9/10

The concentration of 12,000 µg/L of TCA in MW201 indicates that NAPL is likely present in Area 9/10, based on the aqueous solubility limit of TCA. Field studies have shown that groundwater concentrations larger than 1 percent of a contaminant's solubility is strongly indicative of the presence of NAPL (National Research Council 1994, p. 204). The aqueous solubility of TCA ranges from 300,000 to 1,550,000 µg/L at 20 degrees Celsius (Montgomery 1996), meaning that the concentration of dissolved TCA in MW201 represents 0.8 to 4 percent of its aqueous solubility limit. The source of the dissolved TCA at MW201 is located a short distance upgradient (northeast) of the well, between the north end of the Rockford Products parking lot east of 9th Street and the Mid-States Industrial property. Furthermore, given the dominance of chlorinated VOCs, which are denser than water, it is likely that a dense NAPL (DNAPL) is present in the vicinity of MW201. Sudan IV tests did not reveal the presence of NAPL in the shallower portions of the unconsolidated aquifer. DNAPL would not be expected at shallow depth in Area 9/10 because no silt or clay units were encountered in the top 100 feet of the aquifer. Well records from the ISGS indicate the presence of a till unit (i.e. clay) at a depth of about 120 feet near the intersection of 9th Street and Harrison Avenue. If present, DNAPL would sink through the aquifer until the clay unit is reached and then spread laterally downward along the subsurface slope of the clay.

3.5 Initial Ecological Risk Assessment for Area 7

An initial, screening-level ecological risk assessment (ERA) was conducted for the northern portion of Area 7, including the creek. The ERA found both *no risk* and *low risk* to ecological receptors in Area 7. The ERA report, as well as USEPA comments and responses to USEPA comments, are provided in Appendix G.

Section Four

Section 4

Contaminant Fate and Transport

4.1 General Discussion of Fate and Transport

VOCs are the primary groundwater contaminants in the contaminated shallow aquifers in the study area, including chlorinated VOCs, BETX compounds, and ketones. Other contaminants are found only locally, and then primarily only in soils, including certain PAHs, pesticides, PCBs, heavy metals, and cyanide. Of these, all except for cyanide were either undetected in groundwater, or in the case of heavy metals, detected at concentrations likely to represent natural concentrations in the groundwater. Cyanide was detected in one Phase II-sampled well at a concentration of 59.4 ppb; this well is located adjacent to the Area 7 source. These patterns of contaminant distribution in soils and groundwater show that PAHs, pesticides, PCBs, heavy metals, and cyanide are nearly immobile in the subsurface environment, and are therefore not contaminants of concern for groundwater. Therefore, most of the discussion in this subsection will deal with VOC contaminants in soils and groundwater.

4.1.1 Source Area Characteristics

Anomalous concentrations of the target VOC compounds (TCA, TCE, and PCE) were identified in soil gas in all 4 of the potential source areas that were sampled for soil gas. However, some of the areas with low to moderately elevated VOCs likely have those concentrations as a result of either 1) localized or low-concentration occurrences of VOCs in soils; or 2) contaminant volatilization from shallow contaminated groundwater that originated upgradient from the source in question.

Source Areas 4, 7 and 11 have affected downgradient groundwater quality, based on information gathered in the Phase II RI (CDM 1995). Phase II characterization of Area 4 was accomplished through soil gas and subsurface soil sampling, and in the case of Area 7, test pit excavation and sampling. Of the likely source areas, the results of subsurface soil sampling show that high VOC concentrations exist near the top of the saturated zone in Areas 4, 7, and 11.

Non-aqueous phase liquids (NAPLs) comprised of both dense and light NAPL compounds, may be present in each of the potential source areas mentioned above. The Phase II study was not designed to investigate or characterize NAPL zones; however, the SCOU investigation did determine that NAPL is present in Areas 4, 7, and 11. The significance of identifying contaminant sources as a NAPL is that NAPLs will not mix appreciably with water; owing to the limited solubility and volatility of the constituent VOCs. NAPLs also tend to remain at or near their original location below the disposal site for an extended period of time. As a result, any NAPLs existing in the vicinity of the water table in source areas mentioned above pose a

continuing contaminant source to groundwater through the slow dissolution of their constituent compounds into infiltrating rainwater and groundwater.

NAPLs are commonly referred to as either dense non-aqueous phase liquids (DNAPLs) or as light non-aqueous phase liquids (LNAPLs). The distinction between LNAPL and DNAPL is based on the specific gravity of the compounds comprising the NAPL. LNAPLs are commonly comprised of compounds which exhibit a specific gravity less than 1.0, i.e. non-chlorinated VOCs such as benzene, toluene, ethylbenzene, and xylene. DNAPLs are comprised of compounds which exhibit a specific gravity greater than 1.0, such as polychlorinated biphenyls (PCBs) and chlorinated solvents (i.e., PCE, TCE, TCA, DCE).

Given that the specific gravity of water is 1.0, LNAPLs which have migrated through the unsaturated zone have a tendency to float and/or remain in the uppermost portions of an aquifer. LNAPLs tend to form relatively continuous, compact masses near the water table. This is important when considering NAPL characterization and remediation since such bodies are easier to define the limits of as well as to clean up.

NAPL masses comprised predominantly of DNAPL compounds which come in contact with an aquifer will tend to migrate downward within an aquifer system. DNAPL compounds may also be found at the water table interface which appeared to be the case in the SCOU Source Areas mentioned above. Whether or not a DNAPL will migrate downward into an aquifer is strongly dependent upon the thickness and composition of the DNAPL mass accumulated on the water table and the pore size of fracture aperture of the aquifer media at the water table (U.S. EPA, 1993). Once in an aquifer system, the vertical and horizontal location of a DNAPL can be difficult to locate and define. DNAPL occurrences commonly feature hard-to-find narrow stringers and finger-like projections of contaminants that penetrate far into the saturated zone, and may also comprise pools at variable depths within an aquifer existing on strata of lower permeability. Once in contact with a low permeability strata such as clay, silt, or a bedrock interface, the potential for downward migration through such strata depends upon the density of the DNAPL mass, the pore radius or fracture aperture of the strata, the thickness of the DNAPL mass resting on the top of the strata, the capillary pressure gradients within the strata, and hydraulic pressure differentials between the aquifer and potential aquitard/aquiclude. In a heterogeneous geologic medium with multiple aquifers and discontinuous clay/silt layers, DNAPL masses are inherently very difficult to locate and to clean up.

To evaluate whether or not a NAPL mass observed in a suspected source area can be expected to migrate downward into an aquifer, the specific gravities of the various compounds which comprise the NAPL mass should be examined. In Areas 4 and 7, high concentrations of halogenated solvents are present in the NAPL zones; the compounds of this type in greatest abundance (TCA, PCE, TCE, and 1,2-DCE) have specific gravities of 1.28 to 1.63. Significant concentrations of non-chlorinated, aromatic VOCs are also present in Areas 7 and 11; these compounds (xylene, ethylbenzene, and toluene in Areas 7 and 11) have specific gravities of 0.79 to 0.87. In

addition to these compounds on the Target Compound List (TCL), high concentrations of tentatively identified compounds (TICs) were reported from most soils in the high-contamination zones of Areas 4, 7, and 11 during the Phase II investigation (CDM 1995); these compounds, reported from both the VOC and semivolatile scans, were reported at total concentrations of about two to fifteen times that of the total of the chlorinated (heavy) VOCs. The specified compounds (e.g., decane, nonane) or compound groups (alkanes, aromatics) listed as TICs all have low specific gravities (between 0.7 and 1.0). Combined with the light, non-chlorinated compounds on the TCL, the high concentration of these light TICs probably means that the overall specific gravities are less than or close to 1.0 for the contaminant mass in each of Areas 4, 7, and 11. This explains the presence of DNAPL compounds existing at or in the vicinity of the water table in the potential source areas discussed above.

There was no chemical or physical evidence collected during either the Phase I or Phase II investigation to support the existence of a DNAPL at depth within the aquifer system. However, DNAPL was identified in Area 7 in the present investigation, and is likely present in Area 9/10, based on high dissolved concentrations of TCA.

Each of the potential source areas where NAPLs are suspected, differs somewhat in the composition of its specific contamination and often contain mixtures of DNAPL and LNAPL components. In each area, the fact that the high contamination is observed in the immediate vicinity of the water table indicates the bulk of the contaminant mass is comprised of light NAPL compounds. There are significant differences in the composition of the contaminant masses, particularly in the proportion of the various chlorinated VOCs, the proportion of aromatic compounds, and the proportion of degradation daughter products (see subsection 4.5.1 in CDM, 1995). Considering TCL compounds only, the contaminant mass in Area 4 consists primarily of TCA, with no other TCL compounds being detected (detection limit for Area 4 soils was about 8% of the TCA concentration). Considering TICs, however, the total concentration of alkanes and other hydrocarbons was greater than that of TCA by a factor of at least 20 with aromatics being a very small proportion of this total (about 0.2%). The relative lack of aromatic compounds, which would enhance anaerobic conditions favorable to the degradation of the chlorinated VOCs, may be the reason that daughter products are present at fairly low concentrations (less than 10% that of TCA) in Area 4 subsurface soils and downgradient groundwater (see subsection 4.9.2 in CDM, 1995). The combination of TCA and alkanes in Area 4 is distinctive among the likely contaminant source areas, and may represent a waste solvent contaminated with lubricating oils (which are predominantly high-molecular-weight alkanes, in the C-20 to C-30 range). Considering the information presented above and in Section 4.5.1.2 of the Phase II Report (CDM 1995), the highly contaminated zone in Area 4 has dimensions of roughly 50 by 75 feet, with a maximum thickness of at least eight feet. Within that zone, NAPL exists as residual in the vadose zone.

The potential NAPL zone in Area 7 differs from Area 4 in that it is much more complex in composition. In addition to high concentrations of several chlorinated VOCs (TCA, PCE, TCE, and 1,2-DCE), high levels of the aromatics xylene, ethylbenzene, and toluene are present. Among the TICs, even higher concentrations were reported in Phase II soil samples (CDM 1995), with both aromatic and alkanes (including cyclic alkanes) represented in both the VOC and semivolatile scans. Anomalous concentrations of PAHs and several metals were also reported. The relatively high proportion of aromatic compounds in Area 7 may account for the high proportion of biodegradation daughter products in subsurface soils and downgradient groundwater (see subsection 4.9.2 in CDM, 1995). Based on soil borings and soil gas, the area in Area 7 where NAPL is suspected in the vadose zone appears to be a sinuous zone with dimensions of about 200 by 1,200 feet; the thickness of this zone is between five and 20 feet, but is locally as much as 40 feet. Furthermore, DNAPL was confirmed 10 to 12 feet below the water table in the northern hot spot in Area 7. The maximum depth of the DNAPL is not known because drilling was terminated when a contaminated clay layer was found at 29 feet (refer to borehole log for SB7-201 in Appendix C); however, it is likely that the DNAPL would migrate laterally along the topographic surface of the clay unit. It is also noted that Phase II investigation (CDM 1995) identified contaminated silt and clay units in Area 7, suggesting that some of the DNAPL has migrated into the fine-grained sediments.

Based on known uses or occurrences of the various compounds in Area 7 (chlorinated VOCs and aromatics are very commonly used as solvents, alkanes are common in lubricating oils, and PAHs and metals commonly accumulate in dirty oils), the complex assemblage of contaminants may represent disposal of a variety of oil-contaminated waste solvents, paint sludges, paint removers, and varnishes. The quantity and variety of the compounds generally used as solvents suggests that disposal originated from a number of different activities at the same facility, or from activities at a number of facilities. Another possibility is suggested by the fact that the primary solvent-type contaminants in Area 7 (chlorinated VOCs and aromatic compounds) are present across Area 7 in roughly similar proportions (except at the far south, where the PCE-rich contamination may represent an older disposal period), it is possible that the contamination represents disposal from a facility where contaminants from various uses or origins were already mixed.

In Area 11, the area of NAPL contamination differs from those in the other likely source areas in that chlorinated VOCs are likely present at relatively low concentrations compared to the aromatic compounds. It is important to note that in 8 of the 19 soil samples collected in Area 11, detection limits were elevated by 100 to 1,000 times. Because of these sample dilutions, chlorinated VOCs up to 20,000 ppb in some samples would not have been detected. The most abundant compounds detected are xylene, toluene, and ethylbenzene among compounds on the TCL; similar or lower concentrations of total TICs are also present, including both alkanes and aromatics. Based on the high concentrations of xylene and toluene as well as historical property use (former location of Rockford Varnish), the Area 11 contamination probably originated through leakage or spillage of paint or lacquer

solvents, paint thinners, or varnishes. Due to the elevated detection limits, the Area 11 contribution to the total of chlorinated VOCs in downgradient groundwater is unknown. Its high contribution of BETX compounds to the aquifer apparently created a reducing chemical environment that fostered the degradation of certain chlorinated VOCs, resulting in the formation of locally high concentrations of daughter products including vinyl chloride. Based on the soil boring data, there appear to be two separate areas where NAPLs may be present at or above the water table in Area 11, the larger having an estimated areal dimensions of approximately 30 by 120 feet; the thickness of this larger area is generally 5 to 10 feet, and locally as great as 25 feet (see subsection 4.5.1.5 in CDM 1995).

The presence of NAPL in Area 9/10 is highly likely based on the one percent rule for field determination of NAPL (National Research Council 1994). The rule states that the likelihood of NAPL is high if contaminant concentration exceeds one percent of its aqueous solubility limit. In Area 9/10, MW201 had 12,000 µg/L of TCA in sample collected in June 1996, which corresponds to 0.8 to 4 percent of its solubility, depending on the value of solubility used (Montgomery 1996).

4.1.2 Processes Affecting Contaminants in and Near Source Areas

Light NAPL Migration

The disposal of the oily, solvent-contaminated light NAPLs to the ground results in downward migration of the liquid mass toward the water table. During this infiltration process, a certain proportion of the NAPL may be left behind after drainage, retained in soil pores through the force of surface tension; this mass left behind is in residual saturation, and is commonly termed the residual. If enough NAPL is disposed, it will exceed the amount left in near-surface soils in residual saturation and continue to migrate downward; owing to the apparently low specific gravity of the NAPLs in the likely source areas, downward migration will continue until the NAPL reaches the water table. Because of the immiscibility of the NAPL with water and the density of the NAPL mass relative to water, the NAPL will tend to float on the water table, with a minimal degree of mixing. If enough NAPL is disposed, a sizeable volume of NAPL can accumulate at the water table; after reaching the water table, subsequent migration of the NAPL in the short term can occur in three directions: 1) downgradient, following the slope of the water table; 2) vertically downward by a limited amount, whereby the NAPL displaces groundwater directly beneath it due to its accumulated weight; and 3) laterally outward in all directions from the center of the NAPL mass, based on outward-directed hydraulic forces due to the thickness of the NAPL - these are partially balanced by surface tension forces (which tend to hold the NAPL in place). Lateral migration of the NAPL by the first and third mechanisms would tend to spread it out from the specific location(s) of disposal. A possible scenario for a conceptual NAPL model in Area 7 is that sufficient lateral migration has occurred in Area 7 to create a semi-continuous zone of NAPL distribution in the area south of the basketball courts. A semi-

continuous zone of light NAPL may also exist near the top of the saturated zone in Areas 4 and 11, based on soil gas and subsurface soil data.

Two additional modes of migration can affect light NAPLs, on a generally longer time scale than the three mechanisms noted above. The first of these is due to episodic fluctuation of the water table; though most of this movement will be vertical, some horizontal migration is also probable. Evidence for such horizontal migration was found in Area 7, where the width of the NAPL zone (about 100 feet as defined by subsurface soils) is considerably greater than that of the geophysical anomalies in the same areas (about 40 feet). Provided that the liquid wastes and the metallic material were disposed in the same locations, the geophysical anomalies are a better indication of initial disposal patterns, owing to the immobility of the solid metallic material that constitutes these anomalies. Though contaminant migration appears likely, such movement has not been of a large scale since the time of contaminant disposal, as the highly contaminated zone remains centered on the geophysical anomalies; rather, the net effect of this type of migration has been a spreading out of the contaminant mass.

A second mode of NAPL contaminant movement that can occur for a period after disposal is through slow infiltration of NAPL into low-permeability units such as sandy silts and clayey silts. Once a NAPL comes in contact with low-permeability units in the unsaturated zone, resultant lateral migration may be enhanced while downward migration is hindered. The NAPL mass could become perched on low permeability zones, accumulate or pool on the surface of the strata and potentially migrate laterally depending on the orientation of the low-permeability strata and the hydraulic gradient in the aquifer. Migration through such zones will depend on the thickness, density and viscosity of the NAPL mass along with the effective pore size of the strata. If the NAPL continues downward, it can be expected to eventually reach the water table. Where low-permeability units are present at or near the water table, they can become infiltrated with NAPL, especially in areas where a large head of NAPL directly overlies these units. This process is fostered by the ability of organic solvents to drive the interlayer water out of clay minerals, chemically altering and desiccating the minerals, which in turn increases the permeability of clay-bearing units. In addition, the extended period of time available for NAPL to infiltrate lower-permeability units favors the ultimate penetration of NAPL into such zones. Evidence for considering this conceptual model scenario exists in Area 7: the distribution of NAPL masses is controlled primarily by the depth of saturation, rather than by stratigraphy; where silty units are present at or near the water table, these units have become invaded with NAPL material. In fact, some of the highest head-space and contaminant concentrations are present in the silty units. The primary significance of this pattern is for remediation, because cleanup of a NAPL mass in a silty unit may require considerably more time than cleanup of NAPL in a sandy interval.

Volatilization

Because of their volatility, VOCs in contaminant source areas will tend to dissipate through time, via contaminant evaporation that transports contaminants in all directions outward from the contaminant source. Contaminant volatilization accounts for the fact that VOCs can be detected in soil gas samples, allowing delineation of likely contaminant source areas. As it has been shown that extensive contamination exists in Areas 7 and 9/10, the proper measure of the tendency to volatilization from these zones is vapor pressure (in assessing the tendency of contaminants to volatilize from groundwater where they are in a dissolved state, the proper measure of this tendency is the Henry's Law constant).

Contaminant volatilization in contaminant source areas proceeds most readily in permeable soils, and near the upper or lateral margins of the contamination, where soil air is present. As the component VOCs in a contaminant source area have different propensity to volatilization (measured by vapor pressure; see Table 4-1), the composition of the contaminant source will change through time; more-volatile compounds will tend to escape to the atmosphere more readily than less-volatile compounds. In source Area 7, this pattern is illustrated by the relatively large proportion of PCE present in subsurface soils throughout this area. In subsurface soils of Area 7, the ratio of PCE to TCA ranges from 0.03 to 31.2, with a median of 0.67. In soil gas samples collected at locations overlying these subsurface soils in Area 7, however, the ratio of PCE to TCA is distinctly lower, ranging from 0.01 to 2.94, with a median of 0.29. This contrast shows the greater tendency of the more-volatile TCA to escape from the subsurface toward the atmosphere; the end result is that through time, the contaminant source in Area 7 contains progressively higher proportions of less-volatile constituents such as PCE, xylene, and naphthalene.

Solubility

Although the primary groundwater contaminants of concern in the study area are not highly soluble in water, they are soluble enough to be transported for considerable distances in groundwater at concentrations above applicable health standards such as MCLs. The solubilities of the contaminants of concern are listed in Table 4-1. VOC contaminants in contaminant source areas can dissolve in water primarily through the following processes: 1) dissolution in infiltrating precipitation that passes across residual concentrations of VOCs present in the unsaturated zone - such dissolution is relatively important, because of the high surface-to-volume ratio characteristic of residual concentrations; and 2) dissolution by groundwater in the saturated zone - as most sources in the study area contain light NAPL compounds and the permeability of these zones to water is relatively low, most of this dissolution takes place near the margins of the areas of high contamination.

Table -1
Southeast Rockford Groundwater Contamination Site
Rockford, Illinois
Source Control Operable Unit

Physical and Chemical Properties of Selected Chemicals

Compound	Abbreviation	Molecular Weight (g/mole)	Vapor Pressure (mm Hg)	Specific Gravity (Water = 1)	Solubility (mg/L)	H (atm-m ³ /mole)
Vinyl Chloride	VC	62.50	2,530	0.91	2,700 (f)	0.6
Chloroethane	CA	64.52	1,011	0.90	5,740	1.43
Acetone	--	58.08	180	0.79	Miscible	0.24
1,1-Dichloroethene	1,1-DCE	96.94	591	1.22	2,500 (e)	2.13
1,1-Dichloroethane	1,1-DCA	98.96	182	1.17	5,500	1.79
cis-1,2-Dichloroethene	cis-1,2-DCE	96.94	(b)	1.28	3,500	1.74 (d)
trans-1,2-Dichloroethene	trans-1,2-DCE	96.94	265	1.26	6,300	2.09
1,2-Dichloroethane	1,2-DCA	98.96	64	1.24	8,700	1.48
2-Butanone	MEK	72.11	71.2	0.80	353,000 (g)	0.26
1,1,1-Trichloroethane	TCA	133.4	96	1.34	1,175	2.47
Trichloroethene	TCE	131.39	58	1.47	1,000	2.53
Benzene	--	78.11	76	0.88	1,780	2.11
4-Methyl-2-Pentanone	MIBK	100.16	15	0.80	17,000	1.09
Tetrachloroethene	PCE	165.83	14	1.63	150	2.6
Toluene	--	92.14	22	0.87	515	2.65
Ethylbenzene	--	106.17	7.08	0.87	152	3.13
Xylene (h)	--	106.17	8.29 (i)	0.86	152	3.13
bis (2-Ethylhexyl) Phthalate	--	390.57	1.E-07	0.985	0.041	4.2

Vapor Pressure = Vapor pressure at 20 degrees C

Density = Density of pure liquid

Solubility = Aqueous solubility at 20 degrees C

H = Henry's Law Constant

Log K_{OW} = Log(octanol-water partition coefficient)

(These values will vary to some degree because they are derived from different studies)

(a): Values from Montgomery and Welkom (1990)

(b): Pressure value unknown; probably near 265 mm Hg

(c): H is unknown because vapor pressure is unknown; however, using a vapor pressure of 265 mm Hg, $H = 9.7 \times 10^{-3}$

(d): Value denotes log K_{OC}, or log (organic carbon partition coefficient)

(e): Values found in literature range from 210 to 6,400 ppm

(f): Values found in literature range from 60 to 9,150 ppm

(g): Value given at 10 degrees C

(h): Values chosen for xylene were the median values among data from all three isomers

(i): Median value for vapor pressure at 25 degrees C

In general, compounds at similar concentrations in a contaminant source area will tend to dissolve into groundwater in proportion to their solubilities in water. For compounds present at different concentrations in a source area, the influence of solubility in contaminant transport can be observed in comparisons of contaminant ratios in the groundwater to the same ratios in the source area. For example, the ratio of 1,1-DCA to TCA in Area 7 subsurface soils is generally low; where it can be computed, it is generally 0.01 to 0.15; in groundwater downgradient from Area 7, this ratio is higher, most commonly between 0.2 and 1.5. As 1,1-DCA has a higher solubility in water than TCA (see Table 4-1), it is more effectively transferred from source subsurface soils to the groundwater. Similar patterns are present for both 1,2-DCE and 1,1-DCE compared to the lower-solubility TCA.

The opposite pattern is present for PCE, because the ratio of PCE to TCA in subsurface soils in Area 7 is generally between 0.08 and 2.7 (see subsection 4.5 in CDM, 1995); in groundwater downgradient from Area 7 this ratio is lower, being between 0.02 and 0.17. This pattern indicates that PCE is less mobile than TCA, a characteristic that has been noted at numerous groundwater contamination sites. Lower mobility for PCE than for TCA is most likely a function of lower solubility of PCE in water (see Table 4-1), and, conversely, higher degrees of sorption and retardation for PCE.

Low solubility in water probably accounts for the fact that PAHs, PCBs, pesticides, and metals, though locally abundant in several source areas, are not present in groundwater at concentrations above 50 ppb. Of these compounds, only naphthalene and 2-methylnaphthalene were detected in groundwater samples, which is consistent with the fact that they are the only compounds in these groups with solubilities above 1 ppm (Montgomery and Welkom, 1990; Montgomery, 1996). The inverse relationship of solubility and sorption in the study area is also supported by the results of subsurface soil sampling in portions of the contaminant plume that are outside of contaminant source areas (see subsection 4.5.2 in CDM, 1995).

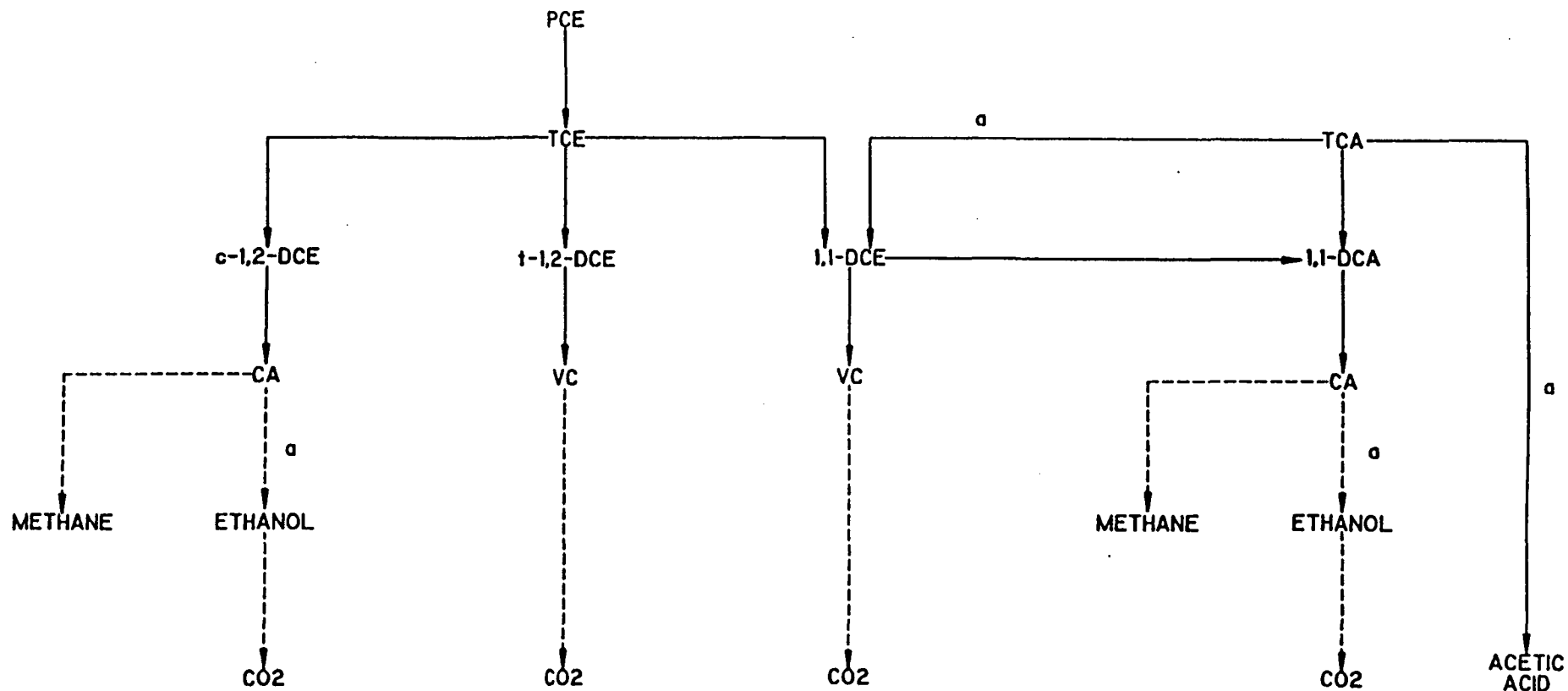
Biodegradation

Once VOCs are disposed in subsurface soils in the likely source areas, a major process affecting their fate is biodegradation. Reductive dechlorination has been found to be a major mode of biodegradation of chlorinated ethanes and ethenes such as TCA, TCE, and PCE (e.g., Vogel et al., 1987; LeSage et al., 1990). This degradation process proceeds under anaerobic conditions, and results in the sequential loss of chlorine atoms; compounds containing one less chlorine atom are formed in each biodegradation step. The transformation of vinyl chloride to carbon dioxide is a biodegradation process, but this proceeds in an aerobic environment (Hartmans et al., 1985). Another biological transformation is from 1,1-DCE to 1,1-DCA (Baek and Jaffe, 1989), but this involves no chlorine loss. In addition to these biologically-mediated transformations, several abiological transformations have been reported. These include the formation of 1,1-DCE from TCA (Vogel et al., 1987), of acetic acid from TCA (Vogel and McCarty, 1987), and of ethanol from chloroethane. Both biological

and abiological transformations are summarized in Figure 4-1. This degradation scheme includes specific pathways that do not appear to be major pathways in the study area, such as the degradation of TCE to trans-1,2-DCE. In addition, the degradation of chloroethane and ethanol have not been verified, but have been suggested in the above references; these pathways are therefore shown as dashed lines.

Several of the degradation processes shown in Figure 4-1 are most likely to have occurred in the study area, particularly in certain areas. As noted above, reductive dechlorination requires an anaerobic environment to proceed. The existence of an anaerobic environment in the likely source areas is supported by the subsurface soil analytical results: in Areas 7 and 11 there are high concentrations of xylene in the highly-contaminated intervals, along with other non-chlorinated aromatic (e.g., toluene) compounds. The significance of these results is that these compounds are readily degradable in an aerobic environment. Chiang et al. (1989) have noted the negative correlation of the BTX (benzene, toluene, and xylene, which are aromatics) compounds with dissolved oxygen (DO) concentration in groundwater. They concluded from studies of a sandy aquifer that BTX removal was directly related to DO concentration, with BTX being absent when DO concentrations were greater than 0.9 mg/L. Conversely, the presence of BTX compounds in the high contaminated portions of Areas 7, and 11 may be interpreted to suggest that DO concentrations are low in these areas, meaning that conditions are either reducing or anaerobic. On the contrary, it is possible that aerobic conditions are present in the immediate vicinity of the highly contaminated portions of Areas 7 and 11, however such a large volume of contaminant mass may have been initially present that the entire BTX components of the contaminant mass has not had sufficient time to degrade. Dissolved oxygen data was not collected during this study so it is not possible to determine the processes that are or have been occurring.

Contamination in Area 4 is different from that in Areas 7 and 11 in that there are relatively small concentrations of the readily-degraded BTX compounds; rather, alkanes were noted at high concentrations. As the alkanes are less susceptible to degradation than the BTX compounds, the consumption of oxygen in the subsurface at Area 4 is likely to be less than in Areas 7 and 11; in turn, conditions may not be anaerobic, and the reductive dechlorination type of degradation may not be as extensive in Area 4. This is consistent with what is observed in subsurface soil and groundwater samples near Area 4: the concentrations of daughter products formed through reductive dechlorination (1,2-DCE, 1,1-DCA, and 1,1-DCE) are at relatively low to undetectable levels in subsurface soils in Area 4, and in groundwater samples downgradient from Area 4 (e.g., at MW130). If the chlorinated VOC portion of the Area 4 plume begins to migrate within the aquifer in the vicinity of the Area 11 source/plume, enhanced degradation of these VOCs may occur due to the anaerobic conditions believed to exist in this area. At which point enhanced concentrations of degradational daughter products may be observed. This may be difficult to distinguish from the degradational processes which are already occurring in Area 11.



LEGEND

PCE = PERCHLOROETHYLENE (TETRACHLOROETHYLENE)
 cis-1,2-DCE = cis-1,2-DICHLOROETHYLENE (cis-1,2-DCE)
 trans-1,2-DCE = trans-1,2-DICHLOROETHYLENE (trans-1,2-DCE)
 CA = CHLOROETHANE
 VC = VINYL CHLORIDE
 CO2 = CARBON DIOXIDE
 a = ABIOLGICAL TRANSFORMATION

——— KNOWN PATHWAY
 - - - POSTULATED PATHWAY

SOUTHEAST ROCKFORD
 SOURCE CONTROL OPERABLE UNIT

DEGRADATION PATHWAYS FOR CHLORINATED VOCs

Biodegradation probably accounts for the existence of a major fraction of 1,1-DCA, 1,2-DCE, chloroethane, vinyl chloride, and some of the TCE present in groundwater and subsurface soils; all of these can form through reductive dechlorination of higher-chlorinated compounds such as PCE, which occurs in an anaerobic environment. The likelihood of an anaerobic environment in several of the likely contaminant source areas has been established above. Biodegradation is also suggested in the study area because of the correlation of certain of the daughter compounds with their likely parent compounds. Though some daughter compounds can form through degradation of different parent compounds, 1,1-DCA forms during biodegradation of TCA, while 1,2-DCE forms through the biodegradation of TCE which in turn may be formed through the biodegradation of PCE. In groundwater contaminant plumes where biodegradation appears to have occurred owing to the presence of relatively abundant daughter products, one of the following two patterns appears to hold: 1) in plumes with significant proportions of both TCE and TCA (i.e., TCE/TCA ratio greater than 0.15), the TCE biodegradation daughter product 1,2-DCE is present at concentrations greater than 1,1-DCA, a TCA daughter product - this applies to the Area 7 plume; 2) in plumes with high TCA but low TCE (TCE/TCA ratio less than 0.15), 1,1-DCA is present at concentrations greater than 1,2-DCE - this applies to the upgradient portion of the Area 9/10 plume. In other words, 1,2-DCE tends to follow its parent compound, TCE, while 1,1-DCA tends to follow its parent compound, TCA; this correlation of parent compound with daughter product supports the process of biodegradation in the contaminant plumes listed. In the other identified contaminant plumes, the concentration of daughter products is too low to discern definite patterns; in some of these cases such as Area 4, the daughter products are at low proportions because significant biodegradation does not proceed, which in turn is probably due to the fact that the requisite anaerobic environment apparently does not exist.

Biodegradation in the subsurface environment also affects the distribution of non-chlorinated compounds. In fact, all of the non-chlorinated VOCs present at elevated concentrations in source areas are readily susceptible to biodegradation in an aerobic environment. This includes the aromatic compounds xylene, toluene, ethylbenzene, and the ketones including acetone and 2-butanone. Potential degradational daughter products include phenols, catechol, cis-1,2-dihydroxy-1,2-dihydrobenzene, benzyl alcohol, benzaldehyde, benzoic acid and other carboxylic acids. These compounds were not analysed for in this study. The carboxylic acids are readily metabolized by most microorganisms. Because of the abundance of the aromatic compounds in the contaminant sources in Areas 7 and 11, combined with the relative ease with which these compounds are degraded, the aromatic compounds have a major influence on the evolution of the contaminant plumes downgradient from these areas.

In particular, the rapid degradation of aromatics in and near both the Area 7 and Area 11 sources appears to create a reducing chemical environment, which in turn fosters the biodegradation of TCA, PCE, and TCE through reductive dechlorination. Owing to the rapid degradation of the aromatic compounds in these areas, contaminant plumes for these compounds are relatively short. The pattern of rapid degradation of aromatics is facilitated by the presence of relatively permeable sandy subsurface soils

and a shallow water table in Areas 7 and 11, which in turn allow relatively easy penetration of oxygen to the unsaturated zone and to shallow groundwater just below; these are the intervals that contain the elevated aromatic compounds, and oxygen is the critical component in the degradation process. Downgradient from the end of the aromatic compound plumes, oxygen is no longer consumed by the degradation of these compounds. The abundance of free oxygen changes the chemical environment from reducing to oxidizing, which means that reductive dechlorination of the chlorinated VOCs ceases. This pattern is vividly illustrated in both the Area 7 and Area 11 plumes: downgradient from the disappearance of BTEX compounds in these plumes, no discernible changes in the proportion of parent to daughter compounds is seen; the chlorinated VOCs, resistant to biodegradation in these oxidizing conditions, migrate from these locations for long distances downgradient (the exception is vinyl chloride, which is susceptible to degradation under oxidizing conditions - it thus parallels the BTEX compounds). This pattern is also observed in the Area 4 plume where there appear to be relatively minor amounts of BTX compounds relative to alkanes. A resultant oxygen-rich environment could be presumed to be present in the vicinity of the Area 4 plume. This oxidizing environment would in turn hinder the degradation of the chlorinated VOCs such as TCE and TCA accounting for the relatively low concentrations of associated degradational daughter compounds such as DCE and DCA.

4.2 Source Area 4

4.2.1 Source Area Characteristics

Soil borings in Area 4 have been drilled to a maximum depth of 81 feet below ground surface. The unconsolidated sediments consist mostly of fine, medium and coarse grained sand. At approximately 61.8 feet bgs a clay layer was observed. A clay layer was also observed in SB4-201 at 62.3 feet bgs. Based on the position of the soil borings and the depth to the clay layer it is believed that this clay layer is continuous across Source Area 4. The thickness of the clay layer was not determined because the soil borings were not advanced beyond the clay to prevent downward migration of contaminants. The clay layer is at least 18 feet thick in Area 4, based on stratigraphic observations at SB4-201.

During the SCOU investigation, NAPL was found in SB4-202 from 27 to 35 feet bgs. TCA was the dominant contaminant in SB4-202 and was also the primary subsurface contaminant during the Phase II investigation in Area 4. As noted, TCA is the most prevalent contaminant in Area 4, but smaller amounts of petroleum based compounds do exist as shown by the SCOU soil gas results. During the Phase II investigation (CDM 1995), the total concentration of alkanes and other hydrocarbons was greater than that of TCA by a factor of at least 20 with aromatics being a very small proportion of this total (about 0.2%). The relative lack of aromatic compounds, which would enhance anaerobic conditions favorable to the degradation of the chlorinated VOCs, may be the reason that daughter products are present at fairly low

concentrations (less than 10% that of TCA) in Area 4 subsurface soils and downgradient groundwater.

The thickness of contamination was determined from past results (CDM 1995) and confirmed during the SCOU investigation. Subsurface soil data and field screening (NAPL testing and headspace analysis) results indicate that the thickness of contamination is 8 feet, extending from 27 feet to 35 feet bgs. The contaminated area, determined during Phase II (CDM 1995) and corroborated during this investigation, is approximately 50 by 75 feet and located underneath the Swebco Manufacturing parking lot.

Based on past use of the property and contamination present it is believed that Source Area 4 has a plume of mixed solvents (mainly TCA) and other alkanes. The combination of TCA and alkanes in Area 4 is distinctive among the likely contaminant source areas, and may represent a waste solvent contaminated with lubricating oils (which are predominantly high-molecular-weight alkanes, in the C-20 to C-30 range). Therefore, the source of contamination is suspected to have come from leaking underground storage tanks that held solvents and waste oils.

4.2.2 Contaminant Fate and Transport

The Area 4 contaminant plume appears to be generated from an area south of Harrison Avenue, approximately 1,500 feet east of Eleventh Street trending northwest to a vicinity north of Harrison Avenue and just east of Eleventh Street. This plume has a distinctive contaminant fingerprint based on the fact that TCA constitutes about 95% of total detected VOCs. The high-TCA fingerprint is replicated in Phase II and SCOU soil gas and subsurface soil samples in and adjacent to Area 4. The proportion of biodegradation daughter products is lower than in most other plumes, perhaps because of low proportions of aromatic compounds in source soils. The correspondence of sampling results from various media suggests that the Area 4 plume derives from a single source located in the upgradient portion of Area 4.

The Area 4 plume contains relatively minor amounts of BTX compounds relative to alkanes. A resultant oxygen-rich environment could be presumed to be present in the vicinity of the Area 4 plume. This oxidizing environment would in turn hinder the degradation of the chlorinated VOCs such as TCE and TCA accounting for the relatively low concentrations of associated daughter compounds such as DCE and DCA detected in the soil and groundwater.

Groundwater was encountered at 31 feet bgs in SB4-201 and approximately 29 feet bgs in SB4-202. Groundwater flow direction is to the west in Source Area 4. The amount of contamination present in the downgradient well MW130 consisted of high levels of TCA (1,000 µg/L) and relatively low levels of TCE, and other daughter products (1,1-DCE, 1,1-DCA and 1,2-DCE) (CDM 1995). MW-22 (northwest of the contaminant source) contained low (20 µg/L) concentrations of TCA. MW-32, located upgradient of the contaminant source, contained 21 µg/L of TCA. Phase II and SCOU

investigation results show that the contaminant plume originates from the area underneath the parking lot of Swebco Manufacturing.

Once contaminants have reached the groundwater, a major retarding factor on their migration rate is their susceptibility to adsorption. In general, the contaminants of concern in the study area have relatively low solubilities in water (less than 1%). This hydrophobic quality means that they are susceptible to adsorption onto solid materials in the aquifers through which they migrate. The solid materials that are most effective in adsorbing organic contaminants are those with high ratios of surface area to volume, such as organic carbon and clay minerals. Although there were problems with the analytical results for total organic carbon samples in Phase II, visual observation of formation samples suggests that the organic carbon content in the unconsolidated aquifer is low in the study area. Clays are locally abundant in the unconsolidated aquifer, and probably contribute significantly to the process of sorption of contaminants. As the susceptibility of a contaminant to sorption is generally inversely related to its solubility in water, low-solubility contaminants such as PCE, naphthalene, and PCBs should be most retarded in their migration in groundwater.

4.3 Area 7

4.3.1 Source Area Characteristics

Area 7 consists of a complex assemblage of unconsolidated sand, gravel, silt, and clay units that overlie dolomite bedrock. The presence of NAPL was confirmed during the SCOU investigation in the northern part of Area 7, in the vicinity of Ekberg Park. DNAPL was found in boring SB7-201 at a depth of 10 to 12 feet below the water table. In addition, the Phase II investigation (CDM 1995) identified extensive soil contamination in the two small valleys that cross Area 7 from south to north. Some of the highly contaminated soils occur within 5 feet of ground surface (e.g. Phase II boring SB7-24). The highly contaminated soils, particularly those in the vicinity of Ekberg Park, have affected groundwater quality in the downgradient direction for overall groundwater flow (i.e. northwest), as well as localized shallow flow which discharges to the creek on the northern boundary. Low levels of the VOCs found in Area 7 soils were also detected in samples of creek water.

4.3.2 Contaminant Fate and Transport

Results of the SCOU investigation indicate that contaminant fate and transport in Area 7 involves the discharge of shallow groundwater to the creek along the northern boundary, in addition to the processes identified in the Phase II report (CDM 1995). Discharge to the creek constitutes a previously unidentified contaminant migration pathway for contaminated soils located at shallow depths, particularly in the northern portion of Area 7 (see also Section 4.9 in CDM 1995). As discussed in Section 4.1 above, active processes in Area 7 include NAPL migration, volatilisation, and

reductive dechlorination through biodegradation of chlorinated ethanes and ethenes such as TCA, TCE, and PCE

4.4 Area 11

4.4.1 Source Area Characteristics

In Area 11 during this SCOU investigation, NAPL contamination was confirmed through field testing and visual observation. Soil samples from SB11-202 (39-45 feet bgs) and SB11-203 (39-43 feet bgs) tested positive for NAPL using the Sudan IV dye. However, subsurface soil NAPL contamination differs from the other source areas in that chlorinated VOCs are likely present at relatively low concentrations compared to the aromatic compounds. It is important to note that in Phase II (CDM 1995), 8 of the 19 soil samples collected in Area 11 had detection limits that were elevated by 100 to 1,000 times the typical value. In the SCOU investigation two soil samples, SB11-202 and SB11-203, had elevated detection limits for the chlorinated solvents of 27,000 µg/kg and 13,000 µg/kg, respectively. Due to these sample dilutions in both investigations, chlorinated VOCs in some samples would not have been detected because of the elevated detection limits.

The most abundant compounds detected in Area 11 subsurface soils are xylene, toluene, and ethylbenzene. Similar or lower concentrations of both alkanes and aromatics are also present. Based on the high concentrations of xylene and toluene, from the Phase II and SCOU investigations, as well as historical property use (former location of Rockford Varnish), the Area 11 contamination probably originated through leakage or spillage of paint or lacquer solvents, paint thinners, or varnishes.

SCOU subsurface soil results, soil gas survey concentrations, field screening (NAPL and headspace), and Phase II subsurface soil results were used to determine contaminant thickness. Based on Phase II and SCOU data, the thickness of NAPL contamination in the western part of Area 11 ranges from 12 feet (SB11-203) to 24 feet (SB11-202). The estimated western contaminated area (north and south of Rohr) is approximately 234 x 60 feet with an average thickness of 15 feet. NAPL contaminant thickness in the central above-ground storage tank area extends from around 35 feet bgs to an unknown depth. The estimated areal extent of NAPL contamination surrounding the AST area has dimensions of 126 x 48 feet. Since the total thickness of contamination is not completely defined, a conservative estimate of 10 feet was used.

4.4.2 Contaminant Fate and Transport

As noted in the biodegradation discussion, reductive dechlorination requires an anaerobic environment to proceed. The existence of an anaerobic environment in Area 11 is supported by the elevated concentrations of xylene in the highly-contaminated intervals, along with other non-chlorinated aromatic (e.g., toluene) compounds. The significance of these results is that these compounds are readily degradable in an aerobic environment. Chiang et al. (1989) have noted the negative

correlation of aromatics like BTX (benzene, toluene, and xylene) compounds with dissolved oxygen (DO) concentration in groundwater. They concluded from studies of a sandy aquifer that BTX removal was directly related to DO concentration, with BTX being absent when DO concentrations were greater than 0.9 mg/L.

Conversely, the presence of BTX compounds in the high contaminated portions of Area 11 suggest that DO concentrations are low in these areas, meaning that conditions are either reducing or anaerobic. Moreover, it is possible that aerobic conditions are present in the immediate vicinity of the highly contaminated portions of Area 11. It is possible that such a large volume of contaminant mass may have been initially present that the BTX component has not had sufficient time to degrade fully. Dissolved oxygen data were not collected during the Phase II (CDM 1995) or SCOU investigations, so it is not possible to determine the extent of aerobic versus anaerobic processes.

Due to the elevated detection limits in both investigations, the Area 11 contribution to the total of chlorinated VOCs in downgradient groundwater is unknown. Its high contribution of BETX compounds to the aquifer apparently created a reducing chemical environment that fostered the degradation of certain chlorinated VOCs, resulting in the formation of locally high concentrations of daughter products including vinyl chloride (CDM 1995).

The Area 11 groundwater contaminant plume consists primarily of aromatic compounds (toluene, xylene, and ethylbenzene), though elevated concentrations (up to 2,900 µg/L; CDM 1995) of several chlorinated VOCs are also present. As defined by the presence of the aromatic compounds, the Area 11 plume is being generated from an area just east of Eleventh Street and just north of Harrison Avenue. The plume of chlorinated VOCs is shorter, with a leading edge existing just west of Eleventh Street; the reasons for this may be that the chlorinated VOCs have not been present in the source soils for as long, that the source volume of chlorinated VOCs was smaller, or that degradation of the chlorinated VOCs has contributed to its shorter plume length.

The Area 11 plume appears to affect the relative concentrations of chlorinated VOCs that originate from other areas, owing to the presence of high concentrations of the aromatics. The degradation of the latter consumes oxygen, which creates an anaerobic environment favorable to the biodegradation of the chlorinated VOCs. This degradation occurs near the upgradient margin of the Area 9/10 plume, and results in high concentrations of daughter products 1,1-DCA and chloroethane, as well as lower concentrations of vinyl chloride.

4.5 Area 9/10

4.5.1 Source Area Characteristics

The stratigraphy of Area 9/10 consists of approximately 240 feet of unconsolidated sand and gravel overlying sandstone bedrock. A clay unit 10-feet thick occurs at a depth of approximately 130 feet in Area 9/10. Existing soil source areas were not directly identified during the SCOU investigation, however source areas are likely present at the Sundstrand Plant #1, and at the former Mid-States Industrial facility, Nylint and Rockford Products. Although DNAPL was not observed, its existence is strongly indicated by a high concentration of dissolved TCA in MW201, which constituted more than 1% of its aqueous solubility limit.

4.5.2 Contaminant Fate and Transport

The likely existence of NAPL in Area 9/10 influences the fate and transport of contaminants. The NAPL is likely present as residual NAPL in the immediate vicinity of the source area and will act as a continuing source of dissolved VOCs to groundwater until remediated. The dissolved concentration of TCA at MW201 is consistent with the existence of a source area located a short distance upgradient (northeast) from MW201, between the north end of the Rockford Products parking lot and the Mid-States Industrial property. In addition to being a continuing source of dissolved VOCs to groundwater, this source may contribute DNAPL to the water table aquifer. DNAPL in Area 9/10 would migrate vertically downward until the clay unit at a depth of 130 feet is reached, and it would provide an ongoing source of dissolved VOCs to the aquifer.

Section Five

Section 5

Summary

The main findings of the Source Control Operable Unit are summarized below.

5.1 Area 4

Subsurface investigation on the south, east, and north side of the former Swebco Manufacturing property indicate that the source of soil VOC contamination in Area 4 is limited to the area beneath the parking lot. Elevated concentrations of soil vapor have migrated eastward from the source area and beneath the western portion of Barrett's Trailer Park, but soil contamination was not found in the park. An 8-foot thick LNAPL zone is present at the water table in the source area, and DNAPL was not observed to a depth of 62 feet, where the top of a clay unit was encountered. The estimated volume of contaminated soil is 30,000 ft³ in Area 4, and the maximum observed soil concentration was 510,000 µg/kg of TCA, the primary VOC contaminant in Area 4.

The Area 4 plume contains relatively minor amounts of BETX compounds relative to alkanes. A resultant oxygen-rich environment could be presumed to be present in the vicinity of the Area 4 plume. This oxidizing environment would in turn hinder the degradation of the chlorinated VOCs such as TCE and TCA accounting for the relatively low concentrations of associated daughter compounds such as DCE and DCA detected in the soil and groundwater.

5.2 Area 7

The extent of VOC soil contamination in the northern part of Area 7 extends northward from the north end of Ekberg Park for a distance of approximately 150 feet. The vertical extent of contamination extends to a depth of at least 27 to 29 feet in the northern part of the park, based on the maximum depth of drilling. NAPL was found at a depth of about 26 feet in one boring, corresponding to 11 feet below the water table. The estimated volume of VOC-contaminated soil is 265,000 yd³ in Area 7 (including the volume estimated during Phase II), and the maximum observed soil concentration was 875,450 µg/kg of total VOCs. Surface water in the creek along the north boundary of Area 7 contains low levels of the same VOCs found in Area 7 soils, indicating that shallow groundwater from Area 7 is locally discharging to the creek. Creek sediments are not currently showing impacts from VOCs.

The NAPL zone in Area 7 is complex in composition as it contains high levels of chlorinated VOCs as well as high levels of aromatics. The relatively high proportion of aromatic compounds in Area 7 may account for the high proportion of biodegradation products in subsurface soils and down gradient groundwater. Area 7 also contains some contaminated silt and clay units suggesting that NAPL has

migrated into the fine-grained sediments. This will have an adverse impact on cleanup times for this area because of the lower soil permeability.

5.3 Area 11

Soil contamination in Area 11 is dominated by the aromatic VOCs ethylbenzene, toluene, and xylene (ETX), which are primarily located in the uppermost part of the saturated zone. This zone of ETX contamination extends from the east edge of the above-ground storage tank area west to 11th Street, based on soil samples collected during the Phase II (CDM 1995) and SCOU investigations. In addition, soil sampling during the SCOU investigation discovered significant ETX contamination at the northwest portion of the Rohr Manufacturing building, thereby extending the area of known contamination by another 150 feet northward. It is likely that elevated ETX concentrations exist beneath the west end of the Rohr building. High ETX concentrations were not found west of 11th Street, approximately 120 feet from the Rohr facility. Chlorinated VOCs are present in Area 11 soils, however elevated detection limits ($> 10,000 \mu\text{g/kg}$) caused by high BETX concentrations prevent accurate determination VOCs in the highly contaminated zones.

It is expected that the relatively higher concentrations of BETX compounds in the aquifer in Area 11 have created a reducing environment that fosters the degradation of VOCs. This results in the formation of locally high concentrations of degradation products such as vinyl chloride down gradient of the area.

5.4 Area 9/10

Significant sources of chlorinated VOC contamination are likely present at Sundstrand Plant #1, based on soil gas and groundwater data that show little or no contamination on the upgradient side of the plant and elevated concentrations on the down gradient side. Moreover, known releases of chlorinated VOCs have occurred at more than one location on the Sundstrand property (IEPA file, 104(e) Request) and at the former Mid-States Industrial facility, the Nylint property, and the Rockford Products facility. Elevated TCA concentration in groundwater immediately down gradient of Sundstrand indicates the presence of NAPL because the aqueous solubility limit of TCA exceeded one percent. This potential existence of DNAPL will influence the fate and transport of contaminants. Based on the subsurface characteristics in the area, DNAPL in Area 9/10 would migrate vertically downward to the clay layer at 130 feet and would then provide an ongoing source of VOCs to the aquifer until remediated.

Section Six

Section 6

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